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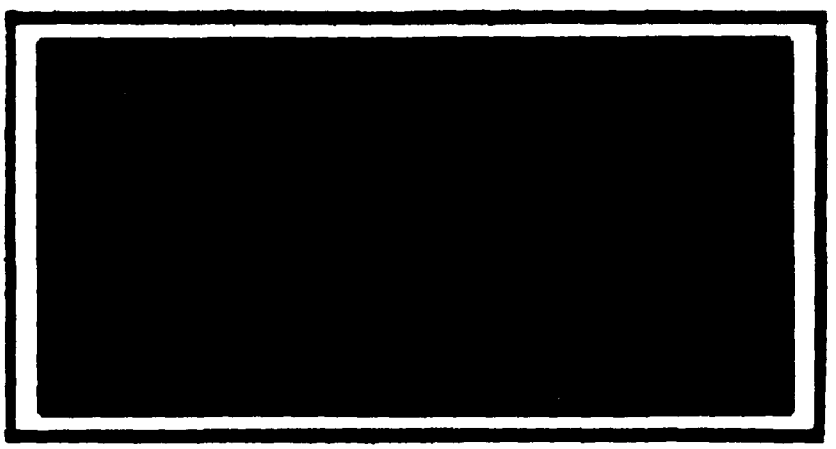

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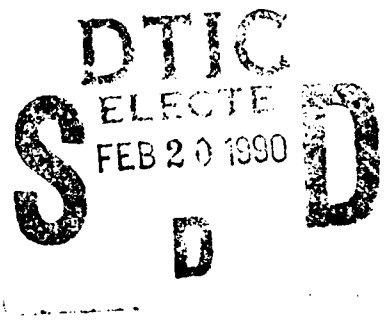

THE EFFECTS OF PSYCHOLOGICAL TYPE AND INFORMATION PRESENTATION ON DECISION MAKING

THESIS

Jerry M. Kain
Captain, USAF

AFIT/GIR/LSM/89D-4

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THE EFFECTS OF PSYCHOLOGICAL TYPE AND INFORMATION PRESENTATION ON DECISION MAKING

THESIS

Presented to the Faculty of the School of Systems and

Logistics of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Information Resource Management

Jerry M. Kain, B.A.

Captain, USAF

December 1989

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Acknowledgments

A very special "thank you" to Patty, Kelly, and Katie -- the most important people in my life. The last 18 months have been hard, but we made it through together and had a pretty fun time of it.

Next, a "thank you" to the United States Air Force for giving me the opportunity to attend AFIT and learn more about information systems, management, and myself. I hope to provide a good return on the investment.

Thanks to Lt Col D. J. McBride, IRM program director, for the 18 months of friendship, leadership, and guidance.

"Thank you" to Dennis Campbell, my thesis adviser. Similarly, a special thanks to Capt Carl Davis for serving as the reader for this thesis.

Finally, thanks to Dr. Fenno for his unsurpassed guidance and fatherly advice.

Jerry M. Kain

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Abstract

This research investigated the relationship between the user's psychological type and mode of information presentation. One hundred twenty-seven Department of Defense managers served as subjects.

The Myers-Briggs Type Indicator was utilized to identify the psychological type of the users while the Information Presentation Mode Survey determined accuracy, efficiency, and preference for seven modes of presenting information or decision making. Because some of the sixteen types were under-represented, psychological type was instead analyzed via five scales: ST/SF/NT/NF, E/I, S/N, T/F, and J/P.

Psychological types were found to vary in their accuracy of decision making. Specifically, Introverts were more accurate than Extraverts, Sensing types were more accurate than Intuitive types, Thinking types were more accurate than Feeling types, and Perceptive types were more accurate than Judgment types. SFs were more accurate than STs, and NTs; NFs were least accurate.

Statistically significant relationships existed between psychological type and efficiency of problem solving. Intuitives and Judgment types were more efficient than Sensing and Perception types by about 45 seconds per

problem. NTs and NFs were almost a half a minute faster per problem than STs and SFs.

Statistical analyses determined that significant relationships also existed a) between accuracy and mode of presentation, b) between preference and mode of presentation, c) between efficiency and mode of presentation, d) and between efficiency and accuracy.

No statistically significant relationships existed between a) between preference and type, and b) between preference and efficiency.

These findings have implications for designers of Management Information Systems. Recommendations are offered as to how best present information to MIS users to optimize decision making.

THE EFFECTS OF PSYCHOLOGICAL TYPE AND INFORMATION PRESENTATION ON DECISION MAKING

I. Introduction

Background

Recently, the United States Air Force converted the functional title of Director of Base Administration to the contemporary title of Director of Information Management. This change in terminology, according to Colonel William Nations, Director of Air Force Information Management and Administration, reflected the evolution of the administration career field towards one of information management. Colonel Nations said this change "points out a key fact that information is a valuable resource." (50:5)

Others outside the United States Air Force also considered information a valuable organizational resource (43:4; 45:67; 12:630; 17:24). Kenneth McDonald, editor of The Consulting Forum, insisted that "in today's economy, information is a corporation's most valuable resource." (42:i). Peter Drucker considered information "the manager's main tool, indeed the manager's 'capital'" (17:24). McFadden and Hoffer reinforced this concept of information as a valuable resource:

> Any organization that fails to treat data (or information) as a resource and to manage it

> effectively will be handicapped....Data are a resource...of value to an organization. (43:4)

Morton Meltzer alerted government and business leaders to "the necessity of treating information as a valuable resource." Meltzer suggested that information is more valuable than labor and capital because:

> Information is not depleted. It loses nothing in quantity, content, power or value. As a matter of fact, value is added as information is used. (45:60)

From this concept that information was a valuable resource evolved a contemporary career field -- information management (13:12, 21). The information manager's role is to manage and direct corporate information and Management Information Systems (MIS) so the organization benefits from these "strategic resources" (13:12; 12:630).

While information is generally understood to be data that has been processed into a meaningful form by the user (13:32), MIS is neither so easily defined nor readily understood. Gordon B. Davis, Director of the Management Information Systems Research Center at the University of Minnesota, defined MIS as a "computer-based technology for providing information to support the operations, management, and decision-making functions in an organization" (13:3). Zmud offered a more generic, working description: "A MIS is report oriented...works with the data already collected and...is decision oriented" (68:91). Though a

MIS does not necessarily have to be computer-based, Davis offered that "it has almost become an article of faith that the heart of a MIS must be a computer" (13:7). Whether computer-based or not, a MIS is designed to acquire data and transform it into information so the manager can use it to make decisions.

Davis pointed out that MIS "does not imply an online man/machine interaction, only an information system to support management" (13:225). Therefore, managers should not be equated to computer operators. Computer operators key in the data; managers receive computer output and use it to make decisions (18:174).

MIS Research Frameworks

McBride explained that a MIS is based on a number of interrelated academic disciplines: management, computer science, general systems theory, sociology, mathematics, operational research, and psychology (40). She suggested that this diversity broadens the boundaries for MIS research, rather than limiting the field (40). Nolan and Wetherbe recognized that this amalgam of disciplines results in "confusing theory and research in MIS" (51:12). According to Jenkins, the "diversity commonly encountered by an academic researcher in the MIS field requires the employment of various research methodologies" (27:3). One such research methodology set forth by Jenkins is the study of MIS Critical Successful Factors (CSF) --those

factors in the MIS manager's environment that are critical to his success (27:4).

Richard Mason and Ian Mitroff proposed a program for MIS research that considers five general categories of CSFs. This model has been considered the first comprehensive framework for MIS research (40):

> An information system consists of:
> 1. one person of a certain **psychological type**
> 2. who faces a problem
> 3. within an organizational context for which he
> 4. needs evidence to arrive at a solution, where the evidence is made available through
> 5. some **mode of presentation**. (39:475; 24:910) (Author emphasis)

Mason and Mitroff submitted this framework because it allowed researchers to explore the characteristics of an MIS through the systematic manipulation of these five CSFs (39:475). Ives stated that this framework has indeed generated the line of research as proposed (24:911).

Similarly, Chervaney et al. offered a framework that attempted to identify the "major elements that determine the effectiveness of a management information system" (24:913). The elements included the decision maker's "**indirectly acquired attributes**" (aptitudes and attitudes) and "directly acquired attributes" (training and experience) as well as the "**characteristics of the information system**", including presentation of information to the user (24:913) (Author emphasis).

This author has emphasized specific CSFs in both frameworks that are examined in this study. Though the terminology differs slightly, both of these models considered the mode of presentation and the user's psychological type as CSFs in an MIS.

Problem Statement

Aside from the acknowledgments that user personality and mode of presenting information are important to MIS design, the central problem remained to establish how information is best presented to each individual user to optimize his understanding of the information. Yet, no clear or definitive studies have related the users' psychological types to the various forms of information presentation. Therefore, research was necessary to determine which, if any, MIS user personality types are related to the various forms of information presentation, or vice versa.

Davis insisted that this relationship is "directly relevant to the design of MIS" (13:151; 12:251). Similarly, Mason and Mitroff stated that the task of MIS designers is to "give each type the kind of information he is psychologically attuned to and will use most effectively" (39:478). Dickson et al. provided further justification for this research:

> Our state of understanding the user/problem/MIS interface is essentially non-existent. It is wrong to assume that all decision makers are the

> same and can effectively function with undifferentiated information systems. (16:914)

If a relationship can be established between mode of presentation and psychological type, then Mason and Mitroff's framework will be empirically supported. Any such relationship could also rebut Huber's conclusion that cognitive style "has not served and will not serve as a satisfactory basis for operational [MIS] design" (56:580). Myers suggested a final justification for this study:

> destructive conflict may exist between people and their job when the job makes no use of the worker's natural combination of perception and judgment but constantly demands the opposite combination. (49:5)

Specific Problem

Thomas conducted earlier research, attempting to identify a relationship between what he termed "user personality" and "mode of information presentation" as two critical success factors (62:5). Drawing upon suggestions in the literature that user personality should influence which information presentation mode to use, Thomas attempted to determine if relationships existed between user psychological type and seven different modes of presenting information. Subsequently, Thomas determined that no statistically significant relationships existed. However, Thomas believed his findings were influenced by his relatively small sample size (n = 64). He noted that "the trend analyses show some very strong implications

that relationships could exist, if the sample size were larger' (62:56). He suggested further study with a larger sample size.

The objective of this study was to replicate Thomas' research with a larger sample size to determine if psychological types are, indeed, related to the accuracy, preference, or efficiency of problem solving when using different modes of presentation of information to make decisions.

This research can be doubly beneficial to information managers. First, it would assist MIS designers by identifying the psychological types of MIS end-users; with this information, MIS designers could develop information systems that are designed specifically for individual end-users. Second, MIS users could better understand how their individual psychological profiles are better served by using a specific mode of information presentation. Both MIS designers and MIS managers should rationally desire to optimize any relationships that are shown to increase efficiency, accuracy, or effectiveness in the decision making process.

Research Question

The research question was: Are psychological types related to the accuracy, preference, or efficiency of problem solving when using different modes of presentation

of information? The null and research hypotheses for this question were:

Ho: There was no relationship between the psychological type of an individual and the individual's accuracy, preference, or efficiency when using different modes of presentation of information when problem solving.

Ha: The psychological type of an individual was related to accuracy, preference, or efficiency when using different modes of information presentation for problem solving.

Investigative Questions

Nine investigative questions were framed to resolve the research question. The investigative questions, with their associated research and null hypotheses, follow below. Pivotal questions, those that were essential to answering the research question, are identified by "*".

1. Did the subjects have different psychological types than the general public? This question determined if the sample type distribution differs from the general public. The answer to this question identified whether the sample was unique, or not, as measured by the Myers-Briggs Type Indicator.

   Ho: The subjects had the same distribution of psychological types as the general public.

Ha: The distributions of psychological types were different than the general public.

2. Were subjects more accurate using some modes of presentation when compared to other modes? Thomas stated that a larger sample size would have shown that a relationship existed between accuracy and psychological type. A difference in accuracy showed that some modes of presentation result in either 'better' or 'worse' performance. Mason and Mitroff theorized that people are more accurate when using:

> the mode of presentation they are psychologically attuned to and will use most often ...Each of these types has a different concept of information and that is important for MIS design. What is information for one type will definitely not be information for all types. (39:478)

Ho: There was no difference in accuracy when solving problems using different modes of information presentation.

Ha: There was a difference in accuracy when solving problems using different modes of information presentation.

*3. Were the psychological types of subjects related to accuracy of problem solving when using different modes of presentation? Though Myers and McCaulley stressed that no psychological type was inherently superior to the other (48:13), no research had yet

determined if psychological type was or was not related to accuracy of decision making. Therefore, this question was the keystone of this research.

Ho: The psychological type of a subject had no relationship with the accuracy of problem solving when using different modes of information presentation.

Ha: Psychological type and accuracy were related.

4. Did subjects prefer some modes of presentation over others? Rejection of this null hypothesis would support previous research that subjects prefer graphical presentation over tabular data.

Ho: Subjects had equal preference for all modes of presentation of information.

Ha: Subjects preferred some modes over others.

*5. Was the psychological type of a subject related to the preferred mode of presentation of information? If preferences existed in the previous question, then this question determined if the preferences varied by type -- the second goal of this research. Watkins suggested that the answer to this question is yes because 'as information is differentially perceived, it may also be differentially preferred (used) in the decision making process' (65:7).

Ho: The psychological type of a subject had no relation to the preferred mode of presentation.

Ha: The preferred mode of presentation and psychological type are related.

6. Were the preference rankings of presentation modes related to the subjects' accuracy of problem solving?

Ho: The preference for mode of information presentation was not related to accuracy.

Ha: Accuracy and preference were related.

7. Were subjects more efficient using some modes of presentation when compared to other modes? The answer to this question determined if some presentation modes were more conducive to efficiency in solving problems.

Ho: Subjects had equal efficiency when solving problems using different modes of presentation.

Ha: Mode of presentation and efficiency were related.

*8. Was the psychological type of a subject related to the efficiency of problem solving when using different modes of presentation of information? The third goal of the research question was to determine if psychological type was related to efficiency of problem solving; this investigative question provided that answer. This question isolated efficiency of problem solving (as measured by time) according to

psychological type. Jungian theory is based on the explanation that individuals perceive data differently and subsequently form judgments differently based on this data (32:3), suggesting that types might be more efficient using certain modes of information presentation.

Ho: Psychological type was not related to efficiency of problem solving when using different modes of presentation.

Ha: Psychological type and efficiency were related.

9. Were accuracy and efficiency related when solving problems with varying modes of presentation?

Ho: Efficiency of problem solving was not related to accuracy.

Ha: Efficiency and accuracy were related.

Scope of this Research

The scope of this research was the same as Thomas' study. Specifically, Department of Defense (DOD) managers, both military and civilian, were surveyed. The subjects were military officers in the ranks of Second Lieutenant through Colonel and civilian managers of comparable grades (GS-7 through GM-15). These managers were reasonably similar in their DOD experience, manager-

ial responsibility, educational level, and use of MIS output in their jobs.

Two similar samples were studied. The first came from the Air Force Institute of Technology (AFIT), Wright-Patterson AFB Ohio, where the subjects were graduate students in the School of Systems and Logistics. The second population came from the Headquarters, Air Force Logistics Command (HQ AFLC) assigned to Wright-Patterson AFB Ohio, where the subjects worked in a logistics related environment.

Two instruments were used in this study. Each subject's psychological type was identified by the Myers-Briggs Type Indicator (MBTI). Chapter II discusses the MBTI and its basis. Thomas' Information Presentation Mode Survey (IPMS) was used to gather data on decision making using different modes of information presentation. The IPMS indicated the participants' accuracy, efficiency, and preference in problem solving. The problems were financially oriented. However, they do not represent the total spectrum of decisions that managers could make in their jobs. The IPMS is discussed in Chapter III.

Assumptions

Seven assumptions to this research are listed below in no specific order of importance. These assumptions were used to establish operational guidelines for this research.

1. These samples of DOD officers and civilian managers were generalizable to the population of entry-level, mid-level, and executive-level managers. Without this assumption, the results/findings could not be generalized beyond the sample populations. This assumption was tested with the first investigative question.

2. The subjects were MIS report users and used some form of information output to make managerial decisions. Likewise, the population of all managers was assumed to make decisions based on information provided by a MIS.

3. The subjects were expected to answer with honesty and not intentionally misrepresent data. It was assumed that with any large sample, truthfulness is achieved by the central tendency of those who overstate and understate their real responses. Also reality at any given moment varies but the variation is equally distributed in a population sample.

4. The subjects' personality types were reflective of their decision making personality. It was assumed that the subject's personality type was constant for this type of business/financial decision making situation.

5. Each subject used different modes of presentation, or at least, preferred to use different modes of presentation when making decisions. This assumption was central to the research because if certain modes were

shown to result in greater accuracy, efficiency, or preference, then the obvious recommendation is to allow managers to use the 'best' mode of presentation. However, with no option to choose mode of presentation, MIS users are forced to use a mode of presentation that may result in sub-optimal decision making.

6. Each subject will want to use the mode of presentation that was shown to be the most accurate for him/her in the decision making process. Research may or may not indicate that the most accurate mode is the same as the preferred or most efficient mode. All other factors being equal, a manager should desire to optimize his accuracy when solving problems in a decision making situation.

7. The research sample was representative of the mean accuracy and variance of the larger population. A basic assumption of the Central Limit Theorem is that with repeated sampling, the mean and sample variances are normally distributed and representative of the population (53:109).

Limitations

This research was bounded by four limitations. These limitations are presented below, again, in no specific order of importance.

1. The findings of this research were limited by those subjects who completed and returned the surveys. To counterbalance this limitation, two separate but similar studies were conducted. Each sample is analyzed separately, but if the samples are found to be typologically similar, both samples can be combined for analysis.

2. The IPMS is oriented to managerial/financial decision situations. It was not intended to reflect other decision making situations (such as personnel oriented decisions) which the managers may also be subjected to in their jobs.

3. The subjects were allowed no other means of calculating the answers to the IPMS except their own mental processes. No calculators or computers were used. This limitation was necessary to ensure subjects made judgments only from the information they actually perceived via the different modes of presentation on the IPMS.

4. The MBTI and the IPMS, when administered together, required approximately 45 minutes to complete. However, subjects may have devoted minimal time and effort toward completing these instruments. Minimal effort may have resulted in sub-optimal decision making on the IPMS. Also, minimal effort in answering the MBTI may have resulted in a different identification of psychological type.

Glossary of Key Definitions

The following terms, necessary for this research, were utilized in this chapter and/or will be further used throughout this report. These terms are defined below as an aid to the reader. As definitions vary according to author and situation, each term is referenced and cited to one specific author.

Accuracy: the difference between a manager's answer and the optimal solution (62:36).

Critical Successful Factors (CSFs): tasks, objectives, or decisions that must go right if success is to result (68:325).

Cognitive style: a grouping of similar psychological types formed by combining one element from the Perception function and one element from the Judging function: ST, SF, NT, NF (62:13).

Efficiency: "The accomplishment of, or ability to accomplish, a job with a minimum of expenditure of time and effort" (55:421). In this study, the user's efficacy as measured by the amount of time needed to solve a problem (62:45).

Information: data that has been processed into a useful form that is meaningful to the recipient and is of real or perceived value in current or prospective decisions (13:32).

Information Presentation Mode Survey (IPMS): an instrument used in this research to gather data on decision making using different modes of information presentation (62:33).

Managers: in this study, those entry-level, mid-level, and executive-level personnel who control, use, and manipulate information to make decisions (6: 4 Mar 89).

Management Information Systems (MIS): a computer-based technology for providing information to support the management, operations, and decision-making functions in an organization (13:3).

Mode of Presentation: the manner in which data is presented to the user (62:2).

Myers-Briggs Type Indicator (MBTI): an instrument that identifies psychological type, based on Carl Jung's theory of personality type (48:1).

Preference: Given an option, the user's choice for a specific mode of presentation (62:41).

Psychological type: one of the 16 personality styles formed by combining one element from each of the four preferences: Extravert/Introvert, Sensing/Intuition, Thinking/Feeling, and Perception/Judgment (48:226).

Summary

This chapter provided the background for this research. The importance of information as an organizational resource was discussed. MIS was defined. Two MIS models were explained as they provide frameworks for this research. The purpose and possible benefits of this research were discussed. The research objective was presented along with the subordinate investigative questions. The scope of this study was also presented, as well as the assumptions and limitations that bound this research. Finally, a glossary of key definitions was presented for ease of reference.

The next chapter provides an in-depth discussion of Jung's theory of psychological type and the Myers-Briggs Type Indicator which is used to identify psychological type. The results of Thomas' study are discussed in detail. Also, other research concerning psychological types and modes of information presentation are discussed.

Chapter II. Literature Review

Introduction

This chapter provides a discussion of literature relevant to this research. The first part presents Carl Jung's theory of personality type. Associated with this, the Myers-Briggs Type Indicator is reviewed as it expands and implements Jung's psychological type theory. Next, the four basic psychological types are explained as they apply to this research. Afterwards, research on different modes of information presentation are reviewed. Finally, previous research, especially Thomas' study, relating cognitive style and/or mode of information to decision making is presented.

Jung's Theory of Personality Type

Swiss psychologist Carl G. Jung developed a comprehensive theory to explain individual differences in personality. Jung theorized that variations in human behavior are the result of observable differences in mental functioning and are not due to random chance (54:7). He postulated that distinct psychological types result from the manner in which an individual perceives information and makes subsequent judgments from those perceptions. Myers wrote that the

> merit of the theory...is that it enables us to expect specific personality differences in

particular people and to cope with the people and the differences in a constructive way. (49:1)

Jung believed that humans are born with a predisposition for any one of these psychological types. However, he also realized that environmental factors are important since the development of one's personality is a lifelong process (32:180; 61:86). Jung theorized that the goal for the first half of one's life is to establish both personal identity and interpersonal relationships in the objective world. He saw middle age as a "natural time of transition in which the personality undergoes necessary and beneficial changes" (61:87). According to Jung, the second half of life was for balancing one's personality by allowing the sub-conscious to grow and exert more influence (61:88; 54:13).

Jung theorized that all mental activity occurs with the Perception functions (Sensing and Intuition), the Judgment functions (Thinking and Feeling) and the Orientation attitudes (Introversion and Extraversion) (54:8; 61:78). Perception is "the process of becoming aware of things, people, occurrences, and ideas" (49:1). Judgment is the process of "making conclusions from the information that is perceived" (48:12). Orientation refers to a person's preference for interaction with the outer world or the inner world (32:7). These mental activities are discussed in detail next.

The Orientation Dichotomy: Extravert/Introvert. Jung theorized that the Extravert/Introvert (E/I) scale is the easiest discriminator of types (54:156). Kroeger and Thuesen described orientation as the "source of one's energy" (31:32). The Introvert (the "inward turning" person) is more interested in the inner world of concepts, ideas, and private thoughts (32:2; 28:182). Introverts favor a quiet environment for reflective work, are detail oriented, and dislike interruptions (54:157). On the other hand, the Extravert (the "outward turning" person) is oriented toward the outer world of people, action, and things (32:10). Extraverts favor a "quick pace with multiple interactions in their work, variety, and less complicated procedures" (32:2).

Jung stressed that everyone uses both of these attitudes; they just differ in their preference for one. Isabel Myers explained that one's preference for either Extraversion or Introversion is the result of one's development, rather than a difference in social adjustment (49:18). The Stanford Research Institute (SRI) International Values and Lifestyles (VALs) program estimated that in the general population, 36% of the males favor Extraversion and the remaining 64% of the males favor Introversion. The VALs survey also estimated that 43% of the females favor Extraversion while the other 57% favor Introversion (41:6).

The Perception Dichotomy: Sensing vs Intuition. Jung theorized that humans have two distinct methods of perceiving information: through Sensing (S) or through Intuition (N). Lawrence reported that the Sensing-Intuition scale "reveals basic learning style differences" (32:38). Myers wrote that this scale "seems to have the most influence on occupational choice" (49:158). Myers and McCaulley estimated that Sensing is favored by 70% of all types while Intuition is the favored function for the other 30% (49:39). More specifically, the SRI estimated that 73% of the males favor Sensing and 27% of the males favor Intuition; for the females, SRI estimated that 78% favor Sensing and 22% favor Intuition (41:6-7).

Sensing refers to the manner in which we become aware of things directly through our five senses (48:2). Sensing individuals prefer facts that come from personal experience and prefer occupations with concrete, realistic, and operational problems (32:3). The Sensing types prefer established order, routine details, and are good at precise work (32:4). Jung noted that men, more than women, were inclined toward Sensing (28:217).

As opposed to Sensing, Intuition (N) can be described as the "indirect perception through our unconscious... ideas that the unconscious tacks on to perceptions coming from the outside" (49:2). Intuitives prefer to pay attention to the meaning behind the facts (32:3). Provost

and Anchors noted Intuitives are impatient with routine details, comfortable with complicated situations, and dislike taking time for precision (54:158). This type prefers unconventional and less clearly defined careers (54:157-158). Jung theorized that women, more than men, would prefer Intuition (28:225).

The Judgment Dichotomy: Thinking vs Feeling. Judgment is the manner by which an individual comes to conclusions. This dichotomy of Thinking/Feeling (T/F) is used to describe one's preference for the technical versus the interpersonal aspects of occupations (49:3). Jacobi described this dichotomy, 'Thinking evaluates from the viewpoint 'true -- false' and Feeling from the viewpoint 'agreeable -- disagreeable' (49:65). Jung described this dichotomy as a rational function because it is used to make judgments about one's experience (61:79). The SRI estimated that 75% of the males prefer Thinking and 25% favor Feeling; conversely, 34% of the females favor Thinking and 66% favor Feeling (41:7).

Thinking (T) types prefer to work with logical and objective data without getting emotionally involved (32:3; 28:192). This type of personality is analytically oriented, firm-minded, and 'are good disciplinarians' (54:159). Jung described the Thinking type as 'their sanction is: the end justifies the means' (28:201). Jung

thought men would comprise the majority of this type (28:203).

Conversely, the Feeling (F) type makes decisions by using personal values and feelings; they are sympathetic, and enjoy pleasing others (32:3-4). This type chooses occupations where they can provide a direct service to others. Jung thought more women than men would prefer Feeling (28:209).

Jung's concept of psychological types was an untestable theory (albeit, a comprehensive explanation) of human psychology because it was not verified by empirical research. The development of the Myers-Briggs Type Indicator in 1962 proffered the opportunity to scientifically apply Jung's theory (32:5).

The Myers-Briggs Type Indicator (MBTI)

The MBTI represents the lifelong work of Isabel Briggs Myers and her mother, Katharine Briggs who designed this instrument to test Jung's theory of psychological type (48:11). The MBTI serves several important functions: it identifies and explains one's type, and it can assist individuals in understanding and appreciating their personality type (48:4).

The MBTI is a forced-choice questionnaire that measures the basic preferences of people in regard to perception and judgment so the effects can be put into

practical use (48:1). The MBTI attempts to sort people into groups of preference; rather than assessing behavior, it assesses personality type (54:182). Myers exhorted that the merit of the MBTI is that it allows researchers to expect specific differences in specific people (48:11).

The MBTI measures Jung's three dichotomies that were previously discussed: E/I, S/N, and T/F. Going one step further, Briggs and Myers also expanded Jung's theory by implementing a Judgment/Perception (J/P) dichotomy that was implicit, but not expounded upon, in Jungian theory (48:11-13; 28:191). Myers wrote that this dichotomy is necessary to complete the identification of type:

> Although people must of course use both perception and judgment, both cannot be used at *the same moment*. So people shift back and forth between the perceptive and judging attitudes... Most people find one attitude more comfortable than the other...and use it as often as possible in dealing with the outer world. (48:8-9)

Kroeger and Thuesen added that this dichotomy is "the most significant source of interpersonal tension...[because it] is difficult to hide on a day-to-day basis" (31:39).

The Judgment/Perception Dichotomy. The Judgment/Perception dichotomy is doubly beneficial: it describes identifiable attitudes and behaviors and it points out one's dominant and auxiliary functions (48:2; 49:8-9). Simply stated, the Judgment (J) types prefer their Thinking or Feeling function more than they prefer their Sensing or Intuition perception. Conversely, the

Perceptive (P) types prefer their Sensing or Intuition function more than their Thinking or Feeling function (32:4). According to Myers, about 55% of all types favor the Judgment process while the other 45% favor the Perception process (32:39). The SRI reported that 70% of the males prefer the Judgment process and 30% of the males prefer Perception. Likewise, 64% of the females prefer the Judgment process while the other 36% favor the Perception process (41:6-8).

Perceptives (P) like spontaneity, open-mindedness, understanding, flexibility, curiosity, and adaptability (49:71-73). They tend to have "too many irons in the fire", postpone unpleasant jobs, have trouble making decisions, and tend to welcome new information on a subject to assist their decision making process (54:160). With tongue in cheek, Kroeger and Thuesen wrote that "thanks to constant new information, it is possible to lose a P somewhere between the front door and the car" (31:42).

While the Perceptive types regard life as something to be experienced and understood, the Judging (J) types believe that life should be decided and organized (49:69). Judging types prefer structure, order, and organization in their lives. With their structured lifestyle, they like planning and decisiveness (49:69). Myers and McCaulley

pointed out that Judging refers to decision making ability, and should not be confused with being judgmental (48:14).

The Dominant and Auxiliary Functions. The Perception dichotomies (Sensing and Intuition) and the Judgment dichotomies are referred to as "functions" while the Introvert and Extravert orientations are referred to as "attitudes". Because of their contradictory nature, only one of the two functions can dominate the personality (61:79-80). Jung proposed that everyone is capable of using all six functions and attitudes. By extension, Myers and McCaulley suggested that everyone is capable of preferring either function in the fourth dichotomy: Judgment or Perception. Individuals differ only by which function dominates and which function becomes the auxiliary (subordinate) function (32:9; 28:192, 222). The most used function becomes the dominant function by becoming part of one's conscious. The second function becomes the auxiliary function; it becomes part of the unconscious where it still has an affect on personality (61:79; 48:15).

Provost and Anchors described the dominant function as the unifying process in a person's life (54:7). However, Provost and Anchors also warned that if people developed only the dominant process, their lives would be

essentially one-dimensional (32:9). Jung theorized that people develop and use the auxiliary function as a balancing function to take care of the less important matters in the world. This auxiliary function serves as the 'extraverted process for the Introvert and the introverted process for the Extravert' (54:9). Furthermore, Isabel Myers described the dominant and auxiliary functions:

> Balance does not refer to equality of the two processes or attitudes; instead, it means superior skill in one, supplemented by a helpful but not competitive skill in the other. The need for such supplementing is obvious. Perception without judgment is spineless; judgment with no perception is blind. Introversion lacking any extraversion is impractical; extraversion with no introversion is superficial. (49: 182)

Basic Groupings of Psychological Types

The four dichotomies measured by the MBTI are each comprised of two elements, giving a total of 16 groupings that make up total personality type. These sixteen types differ only in the priorities they give to each function and in the orientation that the individual typically uses the dominant function (48:12).

Myers has categorized these 16 types by use of her Type Table. This table arranged the types in relation to each other so that those with common characteristics can be readily identified and explained (49:27).

In his study, Thomas combined these sixteen psychological types into four groups. These four combinations

were formed by combining the two functions in the Perception scale with the two functions in the Judgment scale: SF (Sensing and Feeling), ST (Sensing and Thinking), NF (Intuitive and Feeling), NT (Intuitive and Thinking). Grouping the 16 types into just four groups does not imply that there are only four personalities. It implies that people ca· be generally categorized according to the manner they perceive data and make judgments. Mason and Mitroff considered these four combinations to be an effective method for identifying the problem solving style of users (38:113). Myers considered these four combinations to be the most important of the possible combinations (48:33). Similarly, Kroeger and Thuesen offered that these combinations provide the best basis for accurate behavior prediction (31:50). Mitroff and Kilmann reported that

> There is a very strong similarity between the descriptions of those individuals who have the same personality type [and] there is a remarkable and very strong difference between the descriptions of the four personality types. (47:165)

Henderson and Nutt reported that each of these four combinations adopts a unique approach to decision making (20:373). Though each combination shares one characteristic with two of the other groups, each combination is unique because it has its own qualities, interests, values, and traits (49:5). These four combinations are discussed below.

The Sensing/Thinking (ST) Type. This type perceives data from Sensing and forms judgment through Thinking. They are interested in facts that can be readily collected and directly verified by our senses (49:5). Decisions are made with impersonal analysis with a "cause to effect" reasoning process (49:5; 32:A-3).

The Sensing/Feeling (SF) Type. This personality type is also interested in facts that come from Sensing, but makes decisions with personal Feeling. They make their decisions with personal warmth and care because of their interest and concern in the outcome (49:6).

The Intuitive/Feeling (NF) Type. The NF cognitive style prefers using Intuition to Sensing and then uses Feeling to form judgments (49:6). They focus on possibilities, "things that have not happened yet but might be made to happen, and new truths that are not yet known but might be found out" (49:6; 32:A-3). They read between the lines and make decisions with warmth and concern for others.

The Intuitive/Thinking (NT) Type. They, too, prefer intuition and possibilities, but they make subsequent decisions with a business attitude, using an impersonal analysis. (32:A-3). They choose a theoretical or executive possibility and subordinate the human concern

(49:6). Kroeger and Thuesen described this type as being relentless in their pursuit of excellence (31:55).

The Impact of Cognitive Style on MIS

Several MIS researchers have theorized that individual differences -- such as psychological types -- have a significant impact on the design and use of a Management Information System (36:787; 65:7; 39:485; 60:25; 16:921; 20:371; 67:969). Cohen declared that the first criterion for a successful MIS is to specify the user of the system (11:13). Likewise, Davis offered that cognitve style -- the psychological strategy that an individual uses to reach a decision and solve problems -- is directly relevant to the design of MIS (13:151). Mason and Mitroff elaborated on the importance of considering the user's psychological type in MIS design:

> Each of these types has a different concept of 'information' and that is important for MIS design. What is information for one type will definitely not be information for another. Thus, as designers of MIS, our job is not to get (or force) all types to conform to one, but to give each type the kind of information he is psychologically attuned to and will use most effectively....Information should be tailored to specific managers. (39:478)

Despite the perceived importance of this MIS critical success factor, Zmud explained that 'much remains unknown regarding specific relationships...and the relative importance of individual differences' (67:975). Mason and Mitroff concluded that MIS designers must determine which

mode of displaying the information is most conducive to the manager's psychology (39:485). Watkins reported that:

> Information systems designers need to consider the cognitive characteristics of decision makers, and that information reports may be tailored to relatively cognitively homogeneous groups of design makers who perceive information in the same manner. (65:7)

Mason and Mitroff elaborated on the relationship between the four psychological functions and information:

> If one is a pure Thinking type, information will be entirely symbolic...devoid of almost any empirical contents. If one is a Sensation type, information will be empirically devoid of almost all theoretical content. Thus, Sensation types speak of 'raw data', 'hard facts', [and] 'numbers'. For Intuition types, information will be in the form of 'imaginative stories' [and] sketches of future possibilities'. Information for Feeling types takes the form of 'art', 'poetry'...and especially 'stories that emphasize or have a strong moral component. (39:485)

Paul Nutt provided further explanation of these four functions as they apply to MIS:

> These scales determine an individual's preference for types of data and ways to process the data to reach decisions. A Sensing (S) individual prefers hard data that deals in specifics wheras [sic] the Intuitive (N) looks for holistic information which describes hypothetical possibilities and accepts qualitative and subjective information. The Sensing person decomposes while the intuitive looks for the gestalt. Thinking and Feeling approaches can be used to reach a decision... Thinking generalizes and Feeling personalizes. (62:13)

Contrary to this approach that psychological type is an important element in MIS design, two other authors suggested that the study of individual psychological type

in MIS is fruitless. First, Mann et al. argued that cognitive style is one of the least important factors in decision making. They suggested that cognitive style has limited impact on decision making (37:105). They pointed out three concerns with cognitive style. First, each user's cognitive style must be measured. Next, a person's cognitive style does not remain constant across various decision making tasks. Their final point is that a single MIS can not accommodate the cognitive styles of multiple users. Therefore, they suggested the emphasis should be on a flexible hardware/software program that allows users to decide how much information they need as well as how the information will be displayed. This flexibility would allow the information system to conform to all users regardless of their psychological type. (37:106)

The second dissenter, Huber, suggested that cognitive style is over-emphasized in MIS research. He explained that all people are more or less hueristic, the tasks to be performed have more influence than cognitive style, and that humans have a high capacity to adapt to different situations. (23:567)

The literature indicated, however, that research of psychological type is still important to MIS design. Roby, in a rebuttal to Huber's paper, countered that continued research of the effects of cognitive style on a MIS is still important because a MIS designed to fit the

user's preferred style might enhance job satisfaction without impairing performance while forced adaptation to a particular MIS can result in considerable dissatisfaction and long term consequences of absenteeism and employee turnover. (56:581)

Psychological types can be examined and classified according to a number of different theories of human psychology. Mason and Mitroff suggested that for the purpose of MIS research, the Jungian theory of psychological types is the most appropriate measure (39:476). Similarly, Keen and Bronsema advocated the exclusive use of the MBTI and Jungian theory in MIS research. Their recommendation was based on four factors: 1) the MBTI is reliable and well-designed; 2) the MBTI is able to discriminate behavior that is relevant to information systems design and use; 3) the MBTI meets six different tests of validity: conceptual validity, construct validity, convergent validity, discriminant validity, predictive validity, and nomological validity; and 4) the MBTI is a strong model of Jung's psychological type theory (29:24).

Mode of Information Presentation

Computers can now readily transform raw data into useful information and present the output to decision makers in different modes: tabular data, line graphs, bar charts, and pie charts, or combinations of graphs and

tabular data. Ives described these modes of information presentation as the staple of commercially available business graphics (25:16).

According to the two research frameworks previously discussed in Chapter I, these modes of presentation have an effect on the user's accuracy or efficiency in interpreting information. Mason and Mitroff considered mode of presentation a critical success factor because managers need information that is geared to their individual psychology, not to the psychology of the MIS designers (39:485). For this reason, Mason and Mitroff insisted system designers must understand that MIS users differ in the manner they perceive and utilize information (39:485).

Davis generalized the importance of this issue by insisting that the user's assessment of the information system is dependent on the MIS output (13:194). Hodge et al. advised that the mode of information presentation has an affect on its use and managerial decision making (22:24). Finally, Thierauf offered a business perspective on the use of different modes of presentation:

> Because a manager makes decisions and not products per se, his productivity is measured by the quality and timeliness of those decisions....The key to decision making is information, and the key to good managerial decision making is good information....The right kind of graphics system overcomes the inability of tabular data to represent relationships. (63:21)

Benbasat and Taylor identified possible benefits of using different modes of information presentation:

> Tabular data will assist in determining the optimum solution by providing the exact figures to calculate....Graphical reports will provide a quick understanding of the area where a good solution [but not the optimal solution] lies. (4:67)

A graph reduces, summarizes, and highlights information contained in tabular presentation and helps the user gain a better understanding of the information (35:986).

In their experiment, Jarvenpaa et al. concluded that managers prefer graphics over tabular data. They also concluded that different graphical formats had no effect on user accuracy (26:149). These researchers noted that research has been generally inconclusive on the usefulness and effectiveness of graphic presentation vs. tabular data and suggested that the discordant findings in this area are partially due to differences in the quality of graphical presentation. Accordingly, they recommended future researchers emphasize graphic quality to ensure graphs are as clear and easy to read as tabular data (26:144).

Zmud examined user preference for three modes of presentation: tabular data, bar chart, and a graphical format. The graphical mode was the most preferred, followed by tabular data and then the bar chart. He conclusions reinforced the opinion that mode of presentation is 'critical' to the decision maker. (66:195)

Ghani and Lusk performed an experiment that investigated the impact of graphical and tabular data on performance and decision making. Their subjects were divided into four groups, each group given a different mode of information presentation. The four groups either: (1) received tabular reports and then switched to graphical presentations, (2) received graphical reports and switched to tabular reports, (3) used only graphical presentations or (4) used only tabular data. Of importance to this research, Ghani and Lusk concluded that neither accuracy nor efficiency was statistically related with any of the four modes of presentation. (3:66; 19:276)

Benbasat and Dexter reported that graphs may not be an effective mode of presentation. Their experiment examined the subjects' effectiveness (accuracy) when using three different modes of presentation: tabular data, graphical, and a combination of tabular and graphical. They concluded that graphical reports may be disadvantageous since it is 'difficult and time-consuming to get an exact y-value for a given x-value due to interpolation problems' (4:67). These researchers offered three specific findings. First, subjects had a statistically significant preference for different modes of presentation. Combined reports were preferred over graphical reports, which in turn, were preferred over tabular data. Second, the combined presentation mode

resulted in greater accuracy than graph-cal presentation. The tabular mode was not statistically different from either of these two modes. Last, subjects using graphical modes of presentation took less time to make their decisions than those using tabular data. Benbasat and Dexter concluded that MIS designers need to observe the importance of matching the task to the information presentation method because graphical reports are not necessarily better for any or all problems (4:78).

A study by Lucas and Nielsen determined that graphical forms of presentation did not result in better performance than tabular data (35:982). However, they explained (just as Jarvenpaa et al.) that this result could be attributed to graphs that were hard to read. They also concluded that MIS designers need to design systems that are adaptable over time for different users (35:991).

Dickson et al. recommended that designers of information systems understand that 'graphic output...may lead to 'better' decision making' than tabular data. They concluded that designers must be sensitive to the individual differences of MIS users (16:921).

Previous Research on the Effects of Cognitive Style and Mode of Information Presentation on Decision Making

As mentioned in Chapter 1, this research replicates Thomas' study. As previously noted, he found no statistical significance between mode of presentation and personality type in decision making. Thomas noted that his small sample size made statistical analysis difficult at best (62:58). The findings to his specific investigative questions were:

1. The psychological types of his sample were generalizable to the population of mid-level managers.
2. The subjects' accuracy varied with different modes of presentation ($p \leq .059$).
3. Psychological type was not related to accuracy in problem solving.
4. Subjects preferred different modes of presentation over other modes ($p \leq .05$).
5. Psychological type was not related to the preferred mode of presentation.
6. The subjects' accuracy and preference for mode of mode were not related.
7. Efficiency, as measured by the time difference to solve each problem, differed depending on mode of presentation ($p \leq .066$).
8. Psychological type of the user and efficiency in problem solving were not related.

9. Efficiency in problem solving and accuracy in problem solving were correlated ($p \leq .0001$). (62:51-55)

Others studies have examined similar components of this research, either mode of presentation or cognitive style in decision making. Ghani (as reported by Keen and Bronsema) reported that Thinking types prefer and 'do better using' tabular [data] while Feeling types do better with graphical displays (29:34). Lucas investigated the impact of computer based graphics, as a mode of presentation on decision making in a study conducted in the late 1970s. He hypothesized that groups receiving both graphical and tabular output would have higher scores on performance than groups receiving only graphical report. He concluded that graphics had only minimal impact on decision making, but that cognitive style was an important variable in decision making. (34:767-769). Lucas noted that two cognitive styles -- measured as heuristics and analytics -- responded differently to graphical treatment. [A high score on intuition scale as measured by the MBTI is associated with a hueristic decision maker and a low score is associated with an analytic decision maker (35:987)]. Lucas concluded that analytics solve a problem using existing mental models as a reference while heuristics need to see a picture of the data (i.e, graphs) in order to 'just find a problem'

(34:767). Lucas suggested that information systems need to be flexible to accommodate both types of users.

Along the same line, Watkins concluded that information systems designers need to consider the influence of cognitive style of decision making. Additionally, he suggested that information reports can be tailored to homogeneous groups of the same psychological type who perceive data in the same manner. (65:7)

Chapter Summary

This chapter discussed psychological type as it applies to the end-user of information systems. Jung's theory of personality type was described along with the MBTI which operationalized and expanded Jung's theory. Mode of presentation was discussed as it applies to management information systems. Two contrasting views were presented as to the applicability of cognitive style to MIS. Lastly, several studies were reviewed that examined both mode of presentation and cognitive style on decision making. The following chapter provides the methodology necessary to test the research and investigative hypotheses for this study.

Chapter III. Methodology

This chapter presents the methodology to test the central research hypothesis and the nine subordinate hypotheses for the two separate, yet similar, studies. This chapter discusses the population from which the two research samples were drawn, the two instruments needed for this research, the three dependent variables: accuracy, preference, and efficiency of problem solving. (The two independent variables -- psychological type and mode of information presentation -- were discussed in Chapter II). Next, the instrument distribution and collection procedures are discussed. Finally, the statistical analyses and statistical procedures are presented in order to answer the nine investigative questions.

Population

The population for this research was Department of Defense (DOD) military officers (Second Lieutenants, First Lieutenants, Captains, Majors, Lieutenant Colonels, and Colonels) and DOD civilian employees of comparable grades (GS-7 through GM-15). This population represented the three strata of management: entry-, mid-, and executive-level managers.

Originally, this research intended to survey 543 managers assigned to Headquarters, Air Force Logistics Command (HQ AFLC) at Wright-Patterson AFB, Ohio. This sample size was based on the "USAF Guide for the Development of the Attitude and Opinion Survey" which utilized a 95% (± 5%) confidence interval (18:1). This guide reported that the 95% (± 5%) confidence interval "is the minimum one normally specified and desired by all professional surveying organizations" (14:1). However, as a result of higher headquarter's directives, this sample size was reduced to 134 subjects. Anticipating a 40% non-return rate, only 81 surveys were expected to be available for analysis, resulting in the same problem faced by Thomas -- a small sample size making statistical analysis and significance of results difficult to evaluate.

To counter this predicament, a second similar study was conducted by surveying DOD managers assigned to the Air Force Institute of Technology as graduate students. This group was reasonably similar to the HQ AFLC population as far as DOD experience, level of managerial responsibility, educational background, and use of MIS output in their jobs.

The results of these two independent studies were intended to be analyzed separately. However, the distribution of psychological types in the two populations were found to be similar (see Chapter IV for specifics on

data analysis), so the data of both samples were combined for comprehensive statistical analyses. These two populations are discussed below.

Sample 1 - HQ AFLC Managers. The population assigned to HQ AFLC was identified by the HQ AFLC Directorate of Personnel. This group was predominantly civilian managers (92% vs. 8% military managers) with a total size of 3008 personnel. Using a stratified random sample, 134 managers were surveyed (see Table 1, HQ AFLC Population and Sampling Distributions). Of these 134 subjects, only 37 completed and returned usable questionnaires, a 27.6% return rate.

Sample 2 - AFIT Graduate Students. The second population surveyed was DOD military and civilian managers assigned to the Air Force Institute of Technology (AFIT) at Wright-Patterson AFB, Ohio. These managers were all full-time graduate students enrolled in either 15 - or 18-month programs in the School of Systems and Logistics at AFIT. As opposed to the first population, this group was predominantly military officers with the rank of First Lieutenant, Captain, or Major (See Table 2, Population and Distribution of DOD Students Attending AFIT/LS in the 1989 and 1990 Graduate Programs, for distributions). After graduating from AFIT, these students returned to mid-level management positions throughout the DOD. Total

Table 1.

HQ AFLC Population and Sampling Distributions

Grade/ Rank of Managers	Population of each Grade/Rank	Percentage of Total Population	Sample Size	Percentage of Population Surveyed
2Lts -	2	0.06	0	0.00
1Lts -	13	0.43	1	.75
Capts -	78	2.59	3	2.24
Majs -	65	2.16	3	2.24
Lt Cols -	37	1.23	2	1.49
Cols -	46	1.53	2	1.49
GS-7s	220	7.31	10	7.46
GS-8s	7	0.23	0	0.00
GS-9s	308	10.25	14	10.45
GS-10s	1	0.03	0	0.00
GS-11s	411	13.66	18	13.44
GS-12s	964	32.06	43	32.09
GS-13s	608	20.21	27	20.15
GS-14s	171	5.69	8	5.96
GM-15s	77	2.56	3	2.24
Totals	3008	100%	134	100%

Source: (4)

population size was 307. Again anticipating a 40% non-response rate, a census of this population was conducted in order to achieve a more significant response. A total of 90 usable questionnaires were completed and returned from this population, a 29.3% response rate.

Survey Instruments

Two instruments were necessary to conduct this research. The Myers-Briggs Type Indicator (MBTI), Form G, was utilized to identify the psychological types of the

Table 2.

Population and Distribution of DOD Students Attending AFIT/LS in the 1989 and 1990 Graduate Programs

Grade/Rank of Student	Population of Each Grade/Rank	Percentage of This Population
2Lts	0	0.0
1Lts	53	17.3
Capts	229	74.6
Majs	9	2.9
GS-10s	0	0.0
GS-11s	4	1.3
GS-12s	8	2.6
GS-13s	2	.6
GM-14s	2	.6
Totals	307	100%

Source: (21)

subjects. Also, the Information Presentation Mode Survey (IPMS) was administered to collect data on the modes of information presentation.

The MBTI. For the first sample (HQ AFLC managers), a condensed version of the MBTI was used. Of the 126 questions contained on Form G, only the 94 questions that are scored were administered. For the second sample (AFIT graduate students), the full version of Form G was utilized, of which the same 94 questions were scored. Because of copyright provisions, neither version of the MBTI is included as an attachment to this report.

The Myers-Briggs Type Indicator categorizes psychological types into 16 distinct classes. Thomas, because of a small return rate was unable to meet the

underlying assumptions necessary to examine all 16 types. As such, he condensed the 16 types into one scale consisting of the four categories formed from the Perception (Sensing/Intuition) and Judgment (Thinking and Feeling) dichotomies: Sensing-Thinking (ST), Sensing-Feeling (SF), Intuition-Feeling (NF), and Intuition-Thinking (NT). As this research was also unable to meet these assumptions (discussed later), this scale (ST/SF/NT/NF) was examined as well as the E/I, S/N, T/F, and J/P scales. These five scales served as the basis for psychological type.

The subjects marked their answers to the MBTI on a computer-readable answer sheet. A previously developed computer program was used to scan the answer sheets and identify the psychological type of each subject (6).

The Information Presentation Mode Survey. The Information Presentation Mode Survey (IPMS) gathered data on mode of presentation. This instrument was based on the Brand Manager's Allocation Problem which had been utilized in other research and described as a 'typical managerial problem' (44:19; 4:60). The IPMS differed from the Brand Manager's Allocation Problem in that the IPMS used hard-copy presentation whereas the latter used a computer monitor to display the modes of information.

For the IPMS, the subjects assumed the role of regional directors for a national corporation and computed the answers to seven similar financial/managerial problems. Their task was to maximize profits by allocating twenty new stores to three cities in their region. As directors, they had the option of allocating from zero to twenty stores to each city. However, they had to allocate all twenty stores. The only information available to these directors was a 'market survey' that provided profit figures for existing stores in each city.

Each of the seven problems differed by how this information was presented. The differing modes of presentation were: (1) pie charts, (2) pie charts with tabular data, (3) line chart, (4) line charts with tabular data, (5) bar charts, (6) bar charts with tabular data, and (7) tabular data alone. In order to minimize any systematic learning effect, the order in which these problems were presented was varied at random for each subject (62:23). However, this randomization could not prevent any individual learning effect. A copy this instrument can be found in Appendix A: Information Presentation Mode Survey (IPMS).

The Three Dependent Variables: Accuracy, Preference, & Efficiency of Problem Solving

The IPMS collected data on three variables of interest: accuracy, preference, and efficiency of problem solving. Each is described in detail below.

Accuracy of Problem Solving. For investigative questions 2, 3, and 9, accuracy was the dependent variable. Accuracy was measured as the dollar difference between the optimal solution and the subject's answer. If the optimal solution was $1,365 and the subject's answer was $1,300, then the subject was $65 less accurate than the optimal solution (62:36). Hence, accuracy was really a measure of 'error'. When error was large, the subject was least accurate; when error was low, the subject was more accurate. In this research, the term 'accuracy' was used interchangeably with the term 'error'.

Preference for Mode of Presentation. Investigative questions 4, 5, & 6 examined the subjects' preferences for the different modes of presentation. Subjects were asked to rank their preference for each of the seven modes of presentation. They were also given the option of stating that all modes were equally preferred or that none of the modes were preferred. A preference ranking of 1 indicated the most preferred mode of presentation while a preference ranking of 7 indicated the least preferred mode of presentation. All subjects who expressed a preference were included in the analyses; in fact, 122 of the 127 subjects expressed preferences.

For these three questions, the ANOVA analyzed the means of each problem's total preference. For example, if the 122 subjects expressed an average preference ranking

of 2 for bar charts and an average preference ranking of 6 for pie charts, then the difference between these two average ranks indicated that these two modes of presentation were not equally preferred. If the means of these two problems were the same, then no preference existed between the two modes of presentation. By extension, if the means for all seven modes were the same, then no preference existed between the seven modes of presentation. (62:41)

Efficiency of Problem Solving. The last three investigative questions examined efficiency of problem solving. Efficiency was measured as the amount of time necessary for a subject to complete a problem. The IPMS asked each subject to mark both the starting time and stopping time for each of the seven problems. Time was then computed as the difference between the stopping and starting time. Time was rounded to the nearest minute: any seconds less than or equal to 30 were rounded downward and any seconds greater than or equal to 31 were rounded upward. Any time less than 1 minute was recorded as 1 minute. The time necessary to complete any of the problems ranged from a minimum of 1 minute to a maximum of 31 minutes.

Instrument Distribution and Collection Procedures

For the first group (HQ AFLC), the two instruments were combined into one questionnaire for ease of reading and aesthetic purposes. This questionnaire was enclosed in a package that was mailed to each subject. Each package included a cover letter explaining the intent of the survey, a computerized answer sheet for the MBTI, and a pre-addressed return envelope. The subjects were asked to complete the survey within seven days; however all usable responses returned within 28 days of distribution were included in the data for analysis. Thirty-seven (37) subjects from HQ AFLC returned usable questionnaires.

For the second research group (AFIT graduate students), the MBTI was administered separately for academic purposes. Shortly thereafter, the IPMS was distributed to the students for completion. The data from these two instruments were combined later for statistical analyses. Ninety (90) students from AFIT completed and returned usable questionnaires.

Statistical Analyses

Data from the two surveys were analyzed with the Statistical Analysis System (SAS) computer software, programed on a VAX/VMS mini-computer. The statistical procedures used to examine the data were the Chi-Square Analysis, the parametric one-way Analysis of Variance (ANOVA), the Kruskal-Wallis test, (a non-parametric

Analysis of Variance), the F-Test, and Duncan's Multiple Range Test, as well as other descriptive statistics. These procedures are discussed in detail below.

Statistical Analysis for Investigative Question 1. The data necessary to answer this question came from the Myers-Briggs Type Indicator. This question was broken down into two sub-questions. These two sub-questions determined the uniqueness of the research samples as measured by psychological type. Sub-question (a) asked whether the distribution of psychological types from the AFIT and HQ AFLC research samples were similar or different. Sub-question (b) asked if the two separate samples (or the one combined sample as determined above) were unique unto themselves or if they were similar to a larger population.

Analysis Procedures for Sub-Question (a). In order to answer sub-question (a), the two groups were analyzed for similarity of type distribution. The larger sample (n=90) from AFIT provided the observed distribution of psychological types from that sample. The distribution of types in this larger sample also served as the basis for the expected distribution of psychological types for the smaller sample (n=37) from HQ AFLC (i.e., the proportion of each type in the larger sample was multiplied by the total sample size in the smaller sample,

resulting in an expected frequency for this smaller group). This expected distribution was then compared to the actual observed distribution of the smaller sample. Only then was the Chi-Square analysis computed. The following formula was used for the Chi-Square analysis:

$$X^2 = \Sigma (fo - fe)^2 / fe \qquad (1)$$

where X^2 = Chi-Square Test statistic
fo = observed frequency of each cell
fe = expected frequency of each cell
Σ = summation

In order to perform a Chi-Square analysis, some basic assumptions had to be met. Ott wrote that the expected count (frequency) for each cell should be five (5) or more. Noting that this assumption was rather stringent, he submitted that the Chi-Square was still a good procedure if no expected cell count was less than one (1) and if no more than 20% of all expected cell counts were less than 6 (53:221). To this, Christensen added that every cell should have at least one observation (9).

Analysis Procedures for Sub-Question (b). A similar procedure was used to answer sub-question (b). Sub-question (a) determined that the two samples were similar (see Chapter IV for the analysis) so the samples were combined into one aggregate research sample. This aggregate sample was then compared (using the same Chi-Square procedures described above) to two independent

estimates of psychological type representing the general public.

The two different distributions used for this comparison were: 1) Department of Defense Employees -- Military and Civilian Mid & Upper Level Managers in Logistics-Related Occupations (n = 1730) and 2) the SRI International Values and Lifestyle Program Survey (VALs) (n= 1105). Both of these type distributions were considered because their populations generally compared with the sample population studied in this research.

The survey of opportunity for Department of Defense employees reflected a study of military and civilian government employees attending professional continuing education courses and defense logistics management courses at the Air Force Institute of Technology (7:3). This population compared favorably with the research population: government employed Department of Defense managers, typically college educated, ranging from entry-level to mid-level and executive-level managers (7:4). The other estimate of psychological types (also the same one utilized by Thomas for analysis) came from the SRI Values and Lifestyles Survey (VALs) Program. This estimate of type distribution ensued from a survey of 2000 people as part of an ongoing nationwide research project. McCaulley et al. described this estimate as:

> the closest currently available on a nationwide random basis, but is somewhat biased toward more affluent groups, since the data are used for marketing surveys (41:5).

As Thomas noted, this potential for bias should not confound the comparison because the subjects in the research samples were all employed in government management positions similar to the 'affluent' subjects in the VALs estimate (62:26).

Statistical Analyses for Investigative Questions 2-9. The data used to answer these questions came from the Information Presentation Mode Survey. The primary statistical procedure for these questions was the one-way Analysis of Variance (ANOVA). In modeling these one-way ANOVAs, psychological types and mode of presentation were the independent variables while the subjects' accuracy, efficiency, and preference for mode of information were the dependent variables.

Three assumptions were necessary to perform an ANOVA: 1) the observations must be independent (i.e., the measurement of one item doesn't affect the measurement of another item), 2) the observations must come from a normal distribution, and 3) the groups must have equal variance (59:223).

The ANOVAs provided the F-value to indicate relationships between the independent variable and the dependent variable, the probability (p-value) of obtaining an F-

value larger than the one indicated, and the R^2 value (the coefficient of determination). These three statistical values are described below.

The F-Value. The F-value was derived by comparing variances in the model. In an ANOVA, variation resulted from variation due to differences between the groups and variation due to differences within the groups. The ANOVA procedure involved deciding if the between groups variation was larger than would be expected by chance. The underlying principle was that variation due to within group differences was the natural variation that would be expected by chance. The exact F-value procedure, then, was to divide the between groups variation by the within groups variation. If the between groups variation was large relative to the within group variation, the means of the groups were likely to be different. In short, the differences in sample means were judged to be statistically significant or insignificant by comparing them to the variation within samples. (53:403)

The Probability of the F-Value (p-value). In conjunction with the F-value, the ANOVA also determined the probability (the p-value) of obtaining a larger F-value than the one computed. This p-value was the level of significance attributed to the F-value. With the alpha level pre-set for these tests at .05, the null hypothesis

stating that the means were similar was rejected if the p-value was less than or equal to .05. This level of protection was necessary to minimize the likelihood of committing a Type I error (62:24).

The Coefficient of Determination, R^2. The coefficient of determination, R^2, was defined as the proportion of the variability in the dependent variable that was accounted for by the independent variable (53:492). R^2 can range from 0 to 1. The closer it is to 1, the better the model was at accounting for variation in the data, i.e., the more the variation in the data was due to differences between the groups (59:227). On the other hand, an R^2 of 0 indicated that there was no relationship between the variables (59:227).

Duncan's Multiple Range Test. The ANOVA determined if the means differed or not. However, if the means differed, this procedure did not specify **which** means differed. Duncan's Multiple Range Test (a multiple comparison test) provided that answer. This procedure was necessary to analyze the ST/SF/NT/NF scale. Duncan's Test performed all pair-wise comparisons among the different means. It has been described as a 'very powerful' procedure, with a high probability of identifying a difference when a difference actually exists (53:452). As a result, this test was more likely to reject the null

hypothesis of equality than other multiple comparison procedures (9).

The Non-Parametric Analogue: the Kruskal-Wallis Test. If the F-value was found to be statistically insignificant, the non-parametric analogue to the ANOVA -- the Kruskal-Wallis Test -- was used to identify possible significance (59:220). The Kruskal-Wallis test was less restrictive than the regular ANOVA as far as underlying assumptions.

The Kruskal-Wallis Test was based on a Chi-Square approximation to analyze the difference between means (59:230). Specifically, it arranged the data from lowest to highest and assigned a rank score to each value. These rank scores were then summed for each group. Following that, each group sum was then compared to the total for all groups. If this value was larger than the critical value found in the Chi-Square tables (alpha = .05, with the degrees of freedom equal to the total number of groups minus 1), the null hypothesis of identical distribution was rejected. (9)

Summary

This chapter discussed the methodology necessary to analyze the data. The population from which the two research samples were drawn was discussed. The three dependent variables of accuracy, preference, and

efficiency were presented. Also discussed were the survey instruments and instrument distribution and collection procedures. Finally, the statistical tests used to analyze the data were provided. The following chapter presents an analysis of the data collected.

Chapter IV. Data Analysis

As Chapter III discussed the methodology necessary to conduct this research, this chapter provides an analysis of the data collected. The nine investigative questions and the central research question are analyzed.

Investigative Question 1

Investigative Question 1 asked whether the distribution of psychological types from the AFIT and HQ AFLC samples were different a) from each other, and b) from a larger population. These two questions determined the uniqueness of the research samples.

Ninety (90) students from AFIT completed and returned questionnaires while 37 subjects from HQ AFLC completed and returned questionnaires. The MBTI preferences for the 90 (78 males, 12 females) AFIT students were distributed into Myers' Type Table (see Table 3, Frequency of Type Distribution of the AFIT Sample). The 37 (27 males, 10 females) subjects from the AFLC population were also distributed in the same manner (see Table 4, Frequency of Type Distribution of the HQ AFLC Sample). The frequency for each of the 16 psychological types was categorized according to gender, with the total frequency also provided. The psychological types have also been

Table 3.

Frequency of Type Distribution of the AFIT Sample

ISTJ F = 2 M = 17 Total = 19	**ISFJ** F = 2 M = 2 Total = 4	**INFJ** F = 0 M = 2 Total = 2	**INTJ** F = 0 M = 14 Total = 14	n E = 28 I = 62 S = 57 N = 33
ISTP F = 3 M = 11 Total = 14	**ISFP** F = 0 M = 1 Total = 1	**INFP** F = 0 M = 3 Total = 3	**INTP** F = 1 M = 4 Total = 5	T = 74 F = 16 J = 59 P = 31
ESTP F = 0 M = 3 Total = 3	**ESFJ** F = 0 M = 2 Total = 2	**ENFJ** F = 0 M = 2 Total = 2	**ENTJ** F = 2 M = 1 Total = 3	ST = 48 SF = 9 NF = 7 NT = 26
ESTJ F = 2 M = 10 Total = 12	**ESFJ** F = 1 M = 1 Total = 2	**ENFP** F = 0 M = 0 Total = 0	**ENTP** F = 0 M = 4 Total = 4	

(n = 90)

distributed into the five scales: E/I, S/N, T/F, J/P, and ST/SF/NT/NF.

A cursory examination of Table 3, Frequency of Type Distribution of the AFIT Sample, revealed that all cells were represented with the exception of the ENFP cell. Thirteen of the sixteen cells had five or fewer

Table 4.

Frequency of Type Distribution of the HQ AFLC Sample

ISTJ F = 0 M = 11 Total = 11	**ISFJ** F = 0 M = 0 Total = 0	**INFJ** F = 1 M = 0 Total = 1	**INTJ** F = 1 M = 5 Total = 6
ISTP F = 1 M = 3 Total = 4	**ISFP** F = 1 M = 0 Total = 1	**INFP** F = 0 M = 0 Total = 0	**INTP** F = 0 M = 2 Total = 2
ESTP F = 0 M = 0 Total = 0	**ESFJ** F = 0 M = 0 Total = 0	**ENFJ** F = 1 M = 0 Total = 1	**ENTJ** F = 2 M = 1 Total = 3
ESTJ F = 1 M = 2 Total = 3	**ESFJ** F = 0 M = 0 Total = 0	**ENFP** F = 2 M = 0 Total = 2	**ENTP** F = 1 M = 2 Total = 3

(n = 37)

n	
E	12
I	25
S	19
N	18
T	32
F	5
J	26
P	11
ST	18
SF	1
NF	4
NT	14

observations; the remaining three cells had at least 14 observations each.

A similar analysis of Table 4, Frequency of Type Distribution of the HQ AFLC Sample, revealed that five of the sixteen cells (ISFJ, INFP, ESTP, ESFP, and ESFJ) were

devoid of representation. A total of 14 cells had five or fewer observations. The ISTJ cell with eleven observations and the INTJ cell with six observations were the only cells with more than five observations per cell.

Because neither sample met the underlying assumptions (discussed in Chapter III) necessary to conduct a Chi-Square analysis, the full distribution of psychological types could not be properly analyzed. As such, the five scales, E/I, S/N, T/F, J/P, and ST/SF/NT/NF, were used as the basis for psychological type. However, just as Thomas experienced (62:32), the results of the Chi-Square analysis for the cognitive styles scale (ST/SF/NT/NF) must be viewed with some scepticism because two cells (SFs and NFs from the AFLC sample) were under-represented as far as observed cell count. With this limitation in mind, the two sub-questions are answered below.

Sub-question (a). Sub-question (a) asked if the two distributions of psychological type were different from each other. The null hypothesis for this question was: The two distributions were similar as far as distribution of psychological types. The alternate hypothesis was: The two distributions differed. In order to combine the data from the two research samples, the null hypothesis could not be rejected.

To answer this question, five Chi-Square analyses were performed. The results of these tests are found in

Table 5, Summary of the Chi-Square Test Results for Comparing the AFIT and HQ AFLC Samples. All five tests resulted in the null hypothesis of similar distributions not being rejected (the psychological types of the two samples were similarly distributed).

Table 5.

Summary of the Chi-Square Test Results for Comparing the AFIT and HQ AFLC Samples

Scales	Test Value	Degrees of Freedom	Results
ST/SF/NT/NF	3.53	3	Do not reject HO
E/I	.03	1	Do not reject HO
S/N	2.27	1	Do not reject HO
T/F	.46	1	Do not reject HO
J/P	.36	1	Do not reject HO

(a = .05)

This finding was important to this research because it allowed the data from both samples to be combined for all remaining analyses. Combining both samples increased total sample size to 127. Hereafter, this combination of both samples shall be referred to as the 'research sample'. The psychological type distribution of the research sample can be found in Table 6, Frequency of Type Distribution of the Combined Research Sample.

Table 6.

Frequency of Type Distribution of the Combined Research Sample

ISTJ F = 2 M = 28 Total = 30	**ISFJ** F = 2 M = 2 Total = 4	**INFJ** F = 0 M = 3 Total = 3	**INTJ** F = 1 M = 19 Total = 20
ISTP F = 4 M = 14 Total = 18	**ISFP** F = 1 M = 1 Total = 2	**INFP** F = 0 M = 3 Total = 3	**INTP** F = 1 M = 6 Total = 7
ESTP F = 0 M = 3 Total = 3	**ESFJ** F = 0 M = 2 Total = 2	**ENFJ** F = 1 M = 0 Total = 1	**ENTJ** F = 3 M = 3 Total = 6
ESTJ F = 3 M = 12 Total = 15	**ESFJ** F = 1 M = 1 Total = 2	**ENFP** F = 2 M = 2 Total = 4	**ENTP** F = 2 M = 5 Total = 7

(n = 127)

n	
E	40
I	97
S	76
N	51
T	106
F	21
J	85
P	42
ST	66
SF	10
NF	11
NT	40

Sub-question (b). Again, the Chi-Square analyses determined if the distribution of the combined sample was different from the two larger data sets (DOD Employees and SRI VALs) discussed in Chapter III.

Comparison With DOD Employees. The first comparison was performed using the psychological type distribution of the research sample (Table 6) against Campbell's survey of Department of Defense Employees -- Military and Civilian Mid & Upper Level Managers in Logistics-Related Occupations (n=1730) (7:3). The null hypothesis was: The subjects (research sample) had the same distribution of psychological types as Campbell's sample of DOD employees. The results of the five Chi-Square analyses are found in Table 7, Summary of the Chi-Square Test Results for Comparison of the Research Sample with 1) DOD Employees and 2) SRI VALs.

The Chi-Square tests determined that the research sample differed from Campbell's survey sample as far as the distribution of cognitive style and S/N. However, the research sample had more N's (n = 51) than expected (n = 38), and therefore, fewer S's (n = 76) than expected (n = 89). The research sample was similar to Campbell's sample according to the E/I, T/F, and J/P distributions. On balance, it appeared that the research sample was generally representative of Campbell's sample of DOD employees.

Comparison with the SRI VALs Estimate. The research sample was next compared to the SRI VALs estimate of psychological type. Once more the null hypothesis was: The subjects had the same distribution of types as the SRI

Table 7.

Summary of the Chi-Square Test Results for Comparison of the Research Sample with 1) DOD Employees and 2) SRI VALS

1. Survey of DOD Employees

Scale	Test Value	Degrees of Freedom	Results	Significance Level
ST/SF/NT/NF	8.31	3	Reject HO	p≤.025
E/I	1.17	1	Do not reject HO	
S/N	6.38	1	Reject HO	p≤.01
T/F	.32	1	Do not reject HO	
J/P	2.22	1	Do not reject HO	

2. SRI VALs

Scale	Test Value	Degrees of Freedom	Results	Significance Level
ST/SF/NT/NF	85.32	3	Reject HO	p≤.001
E/I	4.22	1	Reject HO	p≤.025
S/N	17.79	1	Reject HO	p≤.001
T/F	55.42	1	Reject HO	p≤.001
J/P	.03	1	Do not reject HO	

VALs estimate of the population. In order to generalize the sample to this population, the null hypothesis could not be rejected.

The results of the five Chi-Square analyses are also provided in Table 7. The psychological distributions of the research sample differed from the SRI VALs distribution on four of the five scales (the lone exception was the J/P scale). However, the research

sample had more I's (n = 87) than expected (n = 76), more N's (n = 51) than expected (n = 31), and more T's (n = 106) than expected (n = 64). On the basis of these findings, the null hypothesis of similar distributions could not be accepted. The sample population could not be generalized to the SRI VALS population on the basis of psychological type distribution.

Summary of Investigative Question 1. In summarizing this investigative question, the two samples were similar to each other. Therefore, their data was combined for further analyses. Secondly, this research sample was found to be relatively similar to Campbell's sample of DOD employees, but different from the SRI VALs estimate. Accordingly, the results of the following investigative questions can be generalized beyond the sample population to Campbell's sample of DOD employees, but not to the SRI VALs estimate.

Investigative Question 2

Investigative Question 2 examined the relationship between the subjects' accuracy and the seven modes of information presentation. If a difference in accuracy does exist, then some modes of presentation resulted in either 'better' or 'worse' performance. The null hypothesis was: There was no difference in accuracy when solving problems using different modes of information

presentation. For this question, accuracy (the dependent variable) was modeled against mode of information presentation (the independent variable). The F-value was computed at 1.82 with 6 degrees of freedom and a resulting p-value of .0926. As this value was larger than the established .05 level of significance, the null hypothesis was not rejected. This question was further examined using the non-parametric analogue, the Kruskal-Wallis Test. This test (using a Chi-Square approximation) resulted in a Chi-Square value of 33.69 with 6 degrees of freedom. The probability of obtaining a larger value was .0001. On the basis of this p-value, the null hypothesis can be rejected, indicating a relationship existed between accuracy and mode of presentation.

Using the results of this non-parametric analysis, the follow-up question, then, was: What modes of presentation resulted in 'better' or 'worse' accuracy? To answer this query, Duncan's Multiple Range Test was used. The results of this analysis are found in Table 8, Comparison of Accuracy and Mode of Presentation, Using Duncan's Multiple Range Test.

The results of Duncan's Test reinforced the results of the non-parametric Kruskal-Wallis Test: accuracy varied when using different modes of presentation. These relationships are discussed below.

Table 8.

Comparison of Accuracy and Mode of Presentation, Using Duncan's Multiple Range Test

Mode of Presentation	Mean Error	Duncan's Grouping	
	Most Accurate		
Pie chart w/ Tabular	42.31	A	
Pie charts	58.28	A	B
Bar charts	60.08	A	B
Bar charts w/ Tabular	66.57	A	B
Tabular data alone	68.26	A	B
Line charts	91.40		B
Line charts w/ Tabular	94.97		B
	Least Accurate		

NOTE: For each Duncan's grouping, those means with the same letter were not significantly different.

n = 127 $p \leq .09$ a (alpha) = .05

As demonstrated in Table 8, two groups (A and B) of similar modes of presentation were evident. The 'B' grouping showed that line charts with tabular data, line charts, tabular data alone, bar charts with tabular data, bar charts, and pie charts were all similar to each other in accuracy. These six presentation methods were individually and collectively different from pie charts with tabular data. In effect, they were all less accurate than the pie chart with tabular data.

The second grouping (A) revealed that pie charts with tabular data, pie charts, bar charts, bar charts with

tabular data, and tabular data were all similar to each other, but different from line charts and line charts with tabular data. These five modes of presentation were more accurate than both forms of line charts.

For informational purposes, these findings were compared with Thomas' findings. Both test statistics fell outside the .05 acceptance limit (Thomas observed a p-value $\leq$ .059). Table 9, Comparison of This Research's Findings to Thomas' Findings for Accuracy (Error) and Mode of Presentation, provides a reference for the accuracy ("error") rankings for both studies. No statistical significance was attributed to this comparison; the two findings were provided only for informational purposes.

To summarize this investigative question, accuracy appeared to vary with mode of presentation. Both forms of pie charts resulted in greater accuracy (less error) while both forms of line charts resulted in less accuracy (greater error). These findings generally supported Thomas' findings.

Now that it has been shown that accuracy varied with mode of presentation, the next investigative question determined whether accuracy varied with the psychological type of the user.

Table 9.

Comparison of This Research's Findings To Thomas' Findings for Accuracy (Error) and Mode of Presentation

	This Research		Thomas' Research	
Mode of Presentation	Mean Error	Rank of Error	Mean Error	Rank of Error
Pie w/Tabular	42.31	1	78.03	2
Pie charts	58.28	2	90.30	3
Bar charts	60.08	3	73.72	1
Bar w/ Tabular	66.57	4	124.05	5
Tabular data	68.26	5	101.64	4
Line charts	91.40	6	133.30	7
Line w/ Tabular	94.97	7	130.02	6

(62:47)

Investigative Question 3

The null hypothesis for this question was: The psychological type of a subject had no relationship with the accuracy of problem solving when using different modes of information presentation. As noted in Chapter II, Myers and McCaulley stressed that no type was inherently superior to any other. Notwithstanding their claim, no research had yet determined if psychological type was or was not related to accuracy of decision making. As such, this question was identified as one of the three pivotal questions for this research.

To test this question, psychological type (the independent variable) was modeled against accuracy (the dependent variable). As accuracy was found to vary in

question 2, this procedure isolated the varying accuracies by psychological type and compared the variances.

To answer this question, five Chi-Square analyses were performed. The results of these tests are found in Table 10, Comparison of Psychological Types and Mean Error for Problem Solving, With Duncan's Grouping. All five tests resulted in the null hypothesis of similar distributions being rejected for each test (i.e., the psychological types of the subjects resulted in different accuracy for each scale).

The follow-on question for this research was, then: What types were most and least accurate? Duncan's Multiple Range Test (also found in the same table) showed that Introverts were more accurate than Extraverts (1.4 times more accurate mean score), Sensing types were twice as accurate than Intuitives, Thinking types were almost twice (1.9 times) more accurate than Feeling types, and Perceptive types were 1.5 times more accurate than Judgment types. Finally, of the four cognitive styles, SFs were most accurate, followed by STs, NTs. NFs were the least accurate. Table 11, Ranking of Presentation Modes in Descending Order of Mean Accuracy for the Five Scales of Psychological Type, presents the relative order of the seven modes of presentation, from the most accurate to the least accurate, for each of the psychological types.

Table 10.

Comparison of Psychological Types and Mean Error for Problem Solving, With Duncan's Grouping

Type	Mean Error	n	Duncan's Grouping	Significance Level
E	82.25	40	A	.03
I	61.29	87	B	
S	49.02	76	A	.0001
N	98.37	51	B	
T	59.74	106	A	.0001
F	114.74	21	B	
J	77.14	85	A	.02
P	52.03	42	B	
SF	28.31	10	A	.0001
ST	52.16	66	B	
NT	72.26	40	B	
NF	193.31	11	C	

NOTE: For each Duncan's Grouping, those means with the same letter were not statistically different from each other.

(n = 127)

Investigative Question 4

These next three investigative questions examined the subjects' preference for the different modes of presentation. Specifically, this investigative question asked if subjects preferred some modes of presentation over the other modes. The null hypothesis was: Subjects had equal preference for all modes of information presentation. The alternate hypothesis was: Subjects preferred some modes over others.

Table 11.

Ranking of Presentation Modes in Descending Order of Mean Accuracy for the Five Scales of Psychological Type

Extravert vs. Introvert

Extraverts	Introverts
1. Pie w/Tab Data	1. Pie w/ Tab Data
2. Bar Chart	2. Pie chart
3. Pie chart	3. Bar chart
4. Bar w/Tab Data	4. Tabular Data
5. Tabular Data	5. Bar w/Tab Data
6. Line Chart	6. Line chart
7. Line w/Tab Data	7. Line w/Tab Data

Sensing vs. Intuition

Sensing	Intuition
1. Pie w/Tab Data	1. Pie w/Tab Data
2. Pie Chart	2. Bar Chart
3. Bar w/Tab Data	3. Pie Chart
4. Bar Chart	4. Tabular Data
5. Tabular Data	5. Bar w/Tab Data
6. Line Chart	6. Line Chart
7. Line w/Tab Data	7. Line w/Tab Data

Thinking vs. Feeling

Thinking	Feeling
1. Pie w/Tab Data	1. Pie w/Tab Data
2. Pie Chart	2. Pie chart
3. Bar Chart	3. Bar Chart
4. Bar w/Tab Data	4. Line Chart
5. Tabular Data	5. Bar w/Tab Data
6. Line Chart	6. Tabular Data
7. Line w/Tab Data	7. Line w/Tab Data

Table 11 continued on next page

Table 11 continued

Judgment vs. Perception

Judgment	Perception
1. Pie w/Tab Data	1. Pie w/Tab Data
2. Bar Chart	2. Line w/Tab Data
3. Pie Chart	3. Pie Chart
4. Bar w/Tab Data	4. Bar w/Tab Data
5. Tabular Data	5. Tabular Data
6. Line Chart	6. Line Chart
7. Line w/Tab Data	7. Bar Chart

Cognitive Styles: STs vs. SFs

STs	SFs
1. Pie w/ Tabular	1. Pie w/ Tabular
2. Bar Chart	2. Pie Chart
3. Pie Chart	3. Line w/ Tabular
4. Bar w/ Tabular	4. Bar w/ Tabular
5. Tabular Data	5. Line Chart
6. Line Chart	6. Tabular Data
7. Line w/ Tabular	7. Bar Chart

Cognitive Styles: NTs vs. NFs

NTs	NFs
1. Pie w/ Tabular	1. Pie w/ Tabular
2. Pie Chart	2. Bar Chart
3. Bar Chart	3. Pie Chart
4. Tabular Data	4. Line Chart
5. Bar w/ Tabular	5. Bar w/ Tabular
6. Line Chart	6. Tabular Data
7. Line w/ Tabular	7. Line w/ Tabular

The one-way ANOVA resulted in an F-value of 85.29 with a resulting p-value of 0.0 (with 6 degrees of freedom). Based on this statistic, the null hypothesis of

equal preference cannot be accepted; the subjects do not prefer all modes of presentation equally. Table 12, Comparison of Mode of Presentation and Mean Preference Ranking, Using Duncan's Grouping, provides the average preference ranking for each method of presentation.

Table 12.

Comparison of Mode of Presentation and Mean Preference Ranking, Using Duncan's Grouping

Mode of Presentation	Mean Preference	Duncan's Grouping
	Most Preferred	
	|	
Bar w/ Tabular	2.12	A
Line w/ Tabular	2.55	B
Tabular data alone	3.76	C
Pie w/ Tabular	3.89	C
Bar chart	4.62	D
Line chart	5.02	D
Pie chart	5.88	E
	|	
	Least Preferred	

NOTE: For Duncan's Grouping, those means with the same letter were not statistically different from each other.

n = 122 alpha = .05 p = 0.0

Again, Duncan's Test was used to determine which modes of presentation were differentially preferred. Duncan's Grouping of similar presentation modes is also found in Table 12. This test showed that there are five specific groupings that differed from each other. Of the 21 possible combinations of presentation modes, 19 were

statistically different as far as preference. The only two exceptions were:

1) Pie charts with tabular data and tabular data alone were similar to each other in preference but different from all others modes of presentation.
2) Line charts and bar charts were similar to each other in preference but different from all the other presentation modes.

Thomas' findings were strikingly similar. He determined that 18 of the 21 possible combinations were differentially preferred while 3 pairs were similarly preferred: the same two combinations listed above, as well as the combination of line charts with tabular data and bar charts with tabular data (62:41). Independently and together, both studies indicated that preferences existed for mode of presentation. A cursory analysis provided an insight into the varying preferences for this research. All graphical methods alone (without tabular data) were least preferred. All other presentation modes accompanied by tabular data were the most preferred methods. Again, these findings supported Thomas' findings: his three least preferred modes were line charts, pie charts, and bar charts; his four most preferred modes all contained tabular data (62:42).

Investigative Question 5

With a statistically significant preference discovered in the previous question, this question asked if the psychological type of a subject was related to preference for a mode of presentation. This was the second of the three pivotal questions for this research. The null hypothesis was: The psychological type of a subject had no relationship to the preferred mode of presentation.

To answer this question, each of the five scales representing psychological type (the independent variable) was modeled against the preference rankings (the dependent variable) for each problem. This modeling allowed preference to be categorized by mode of presentation. This modeling resulted in 35 different F-values; five F-values (one for each scale) for each of the seven modes of presentation. All 35 test results are provided for informational purposes in Appendix B: Comparison of Psychological Types and Preference By Mode of Presentation. The summary of these analyses are provided in Table 13, Summary of Significance Levels for Psychological Types and Preference Rankings By Mode of Presentation. Table 14, Rank Order (from Highest to Lowest) of Preference for Mode of Presentation According to Psychological Type, displays a rank ordering of each types' preference for the seven modes of presentation. A

Table 13.

Summary of Significance Levels for Psychological Types and Preference Rankings By Mode of Presentation.

1. Bar Chart with Tabular Data

Scale	P-value	
ST/NT/NF/SF	$p \leq .41$	
E/I	$p \leq .33$	
S/N	$p \leq .42$	
T/F	$p \leq .49$	
J/P	$p \leq .01$	***

2. Line Chart with Tabular Data

Scale	P-value
ST/NT/NF/SF	$p \leq .16$
E/I	$p \leq .25$
S/N	$p \leq .77$
T/F	$p \leq .24$
J/P	$p \leq .78$

3. Tabular Data

Scale	P-value
ST/NT/NF/SF	$p \leq .51$
E/I	$p \leq .58$
S/N	$p \leq .16$
T/F	$p \leq .35$
J/P	$p \leq .60$

4. Pie Chart with Tabular Data

Scale	P-value
ST/NT/NF/SF	$p \leq .59$
E/I	$p \leq .99$
S/N	$p \leq .81$
T/F	$p \leq .19$
J/P	$p \leq .96$

5. Bar Chart

Scale	P-value	
ST/NT/NF/SF	$p \leq .21$	
E/I	$p \leq .97$	
S/N	$p \leq .30$	
T/F	$p \leq .08$	
J/P	$p \leq .04$	***

(Table 13 continued on next page)

Table 13. (Continued)

6. Line Chart

Scale	P-value
ST/NT/NF/SF	$p \leq .83$
E/I	$p \leq .37$
S/N	$p \leq .74$
T/F	$p \leq .49$
J/P	$p \leq .99$

7. Pie Chart

Scale	P-value
ST/NT/NF/SF	$p \leq .74$
E/I	$p \leq .86$
S/N	$p \leq .40$
T/F	$p \leq .53$
J/P	$p \leq .52$

rank of 1 reflects the most preferred mode for that type, down to a rank of 7 which reflects the least preferred mode of presentation for that psychological type.

With two exceptions, none of the 35 analyses in Table 13 showed a statistically significant relationship between type and preference ranking. The two exceptions were the J/P scale for bar charts ($p \leq .04$) and bar charts with tabular data ($p \leq .01$). In both cases, the Judgment types preferred those two modes more than the Perceptive types preferred those presentation modes. Duncan's Multiple Comparison Test found no statistically significant preference for any of the five scales. The results of Duncan's Tests can also be found in Appendix B: Comparison

Table 14.

Rank Order (from Highest to Lowest) of Preference for Mode of Presentation According to Psychological Type

Extraverts vs. Introverts

Extravert	Introvert
1. Line Chart	1. Bar Chart
2. Bar Chart	2. Line Chart
3. Line w/Tab Data	3. Pie Chart
4. Pie Chart	4. Bar w/ Tab Data
5. Pie w/Tab Data	5. Line w/ Tab Data
6. Bar w/Tab Data	6. Pie w/ Tab Data
7. Tabular Data	7. Tabular Data

Sensing vs. Intuition

Sensing	Intuition
1. Bar Chart	1. Line Chart
2. Line Chart	2. Bar Chart
3. Pie Chart	3. Pie w/ Tab Data
4. Bar w/ Tab Data	4. Line w/ Tab Data
5. Line w/ Tab Data	5. Bar w/ Tab Data
6. Pie w/ Tab Data	6. Tabular Data
7. Tabular Data	7. Pie Chart

Thinking vs. Feeling

Thinking	Feeling
1. Bar Chart	1. Line Chart
2. Line Chart	2. Bar w/ Tab Data
3. Pie Chart	3. Bar Chart
4. Bar w/ Tab Data	4. Line w/ Tab Data
5. Line w/ Tab Data	5. Pie w/ Tab Data
6. Pie w/ Tab Data	6. Pie Chart
7. Tabular Data	7. Tabular Data

Table 14 continued on next page

Table 14 continued

Judgment vs. Perception

Judgment	Perception
1. Bar Chart	1. Bar Chart
2. Line Chart	2. Line Chart
3. Line w/ Tab Data	3. Pie w/ Tab Data
4. Pie Chart	4. Pie Chart
5. Bar w/ Tab Data	5. Bar w/ Tab Data
6. Pie w/ Tab Data	6. Line w/ Tab Data
7. Tabular Data	7. Tabular Data

Cognitive Styles Scale

STs vs. SFs

STs	SFs
1. Bar w/ Tabular	1. Bar w/ Tabular
2. Line w/ Tabular	2. Line w/ Tabular
3. Tabular Data	3. Tabular Data
4. Pie w/ Tabular	4. Bar Chart
5. Bar Chart	5. Pie w/ Tabular
6. Line Chart	6. Line Chart
7. Pie Chart	7. Pie Chart

NTs vs. NFs

NTs	NFs
1. Bar w/ Tabular	1. Bar w/ Tabular
2. Line w/ Tabular	2. Line w/ Tabular
3. Pie w/ Tabular	3. Bar Chart
4. Tabular Data	4. Pie w/ Tabular
5. Bar Chart	5. Line Chart
6. Line Chart	6. Tabular Data
7. Pie Chart	7. Pie Chart

of Psychological Types and Preference By Mode of Presentation.

On the basis of these tests, the null hypothesis of no relationship between psychological type and preference

for mode of presentation was not rejected. These findings were similar to Thomas' finding. Both findings indicated that the variance of preference rankings was due to a factor other than psychological type.

Investigative Question 6

Investigative Question 6 was a follow-on to investigative questions 2 and 4. Question 2 determined that a relationship existed between accuracy and mode of presentation. Question 4 determined that a relationship existed between preference and different modes of presentation. This question was designed to determine if preference was related to accuracy. The null hypothesis was: A preference ranking for mode of information presentation was not related to accuracy.

The one-way ANOVA resulted in an R^2 value of .4% (.004). The F-value was .60 with a corresponding p-value of .73 (using 6 degrees of freedom). On the basis of this, the null hypothesis of no relationship between psychological type and preference for mode of presentation was not rejected. No matter what mode the subjects' preferred the most, it was not statistically different than the modes they preferred second, third, etc. as far as mean accuracy. Just as Thomas explained, "A high or low preference for a mode of presentation does not mean that accuracy will also be high or low" (62:44). Again,

as Thomas noted, this research failed to show what, if anything, besides mode of preference was influencing the preference rankings (62:45).

Investigative Question 7

This question asked if subjects were more efficient using some modes of presentation when compared to other modes. The associated null hypothesis was: Subjects had equal efficiency when solving problems using different modes of presentation.

The F-value produced by the analysis of variance was 5.57 with an associated probability of .0001 (using 6 degrees of freedom). The coefficient of determination -- R^2 -- was 3.69% (.0369).

Just as before, Duncan's Test was applied to determine just which methods of presentation differed. The results of this analysis are offered in Table 15, Comparison of Mode of Presentation and Efficiency of Problem Solving Using Duncan's Multiple Range Test. This table shows that bar charts and line charts were similar to each other, and different from all other modes of presentation in efficiency. Subjects who used the graphs alone (without the aid of tabular data) were the most efficient decision makers. Specifically, subjects who used bar charts and line charts were the two most efficient groups of decision makers. Conversely, the

Table 15.

Comparison of Mode of Presentation and Efficiency of Problem Solving Using Duncan's Multiple Range Test

Mode of Presentation	Mean Efficiency (measured in minutes)	Duncan's Grouping	
	Most Efficient		
Bar chart	2.54	A	
Line chart	2.74	A	
Pie chart	3.81		B
Bar w/ Tabular	3.89		B
Line w/ Tabular	3.94		B
Pie w/ Tabular	4.10		B
Tabular data alone	4.62		B
	Least Efficient		

NOTE: For Duncan's grouping, those means with the same letter were not significantly different.

n = 127 $p \leq .0001$ a = .05

subjects who used the presentation modes containing tabular data were the least efficient decision makers.

As noted in Table 16, Comparison of Thomas' Findings with The Results of This Research on Efficiency of Problem Solving, the results of this survey supported Thomas' findings. As a matter of fact, his findings were the same as this research, except for reversing the 1 and 2 rankings, and reversing the 3 and 5 rankings.

Investigative Question 8

As efficiency was found to vary in the previous section, the eighth investigative question asked if the

Table 16.

Comparison of Thomas' Findings with The Results of This Research on Efficiency of Problem Solving

	This Research		Thomas' Research	
Mode of Presentation	Mean Efficiency	rank	Mean Efficiency	rank
Bar chart	2.54	1	2.47	2
Line chart	2.74	2	2.31	1
Pie chart	3.81	3	2.91	5
Bar w/ Tabular	3.89	4	2.76	4
Line w/ Tabular	3.94	5	2.48	3
Pie w/ Tabular	4.10	6	3.35	6
Tabular data alone	4.62	7	3.59	7

(Source 62:47)

psychological type of a subject was correlated with efficiency of problem solving. The null hypothesis was: Psychological type was not related to efficiency of problem solving when using different modes of presentation. This question answered the third pivotal question of this research. Jungian theory was based on the explanation that psychological types perceive data differently and make judgments based on the data perceived, suggesting that some types might be more efficient using certain modes of information presentation.

This ANOVA was modeled with psychological type as the independent variable and efficiency (time) as the dependent variable. As always in this research, the alpha level was pre-set at .05. The results of the five

analyses are found in Table 17, Comparison of Psychological Type and Mean Efficiency of Problem Solving, Using Duncan's Multiple Range Test. Three of the five scales showed statistically significant relationships: ST/SF/NT/NF ($p \leq .001$); S/N ($p \leq .001$); and J/P ($p \leq .01$).

Duncan's Multiple Test was also utilized to determine which pairs of types differed as far as efficiency of problem solving. The results of this test are also found in Table 17. Though the global F-Test showed a strong level of significance ($p \leq .001$) for the cognitive styles, Duncan's Test showed that none of the pairs involved differed as far as efficiency of problem solving. For comparison purposes, Thomas also found no statistical significance between cognitive style and efficiency.

A cursory analysis revealed that NTs were the most efficient of the four cognitive styles and STs were the least efficient at problem solving. In fact, both Intuitive types (NTs and NFs) were more efficient than the Sensing types (STs and SFs). Similarly, N's were more efficient than S's by almost 3/4 of a minute per problem, and J's were more efficient than P's by almost 3/4 of a minute per problem.

Time was not a factor for E's and I's, nor for T's and F's. Though I's and T's were more accurate than E's and F's, the time they required to complete the problems was statistically insignificant.

Table 17.

Comparison of Psychological Type and Mean Efficiency of Problem Solving, Using Duncan's Multiple Range Test

Type	Mean Efficiency		Duncan's Groupings		Significance Level
E	3.90	40	A		p ≤ .18
I	3.55	87	A		
S	3.98	75	A		p ≤ .001
N	3.20	52		B	
T	3.70	106	A		p ≤ .53
F	3.49	21	A		
J	3.45	85	A		
P	4.10	42		B	p ≤ .01
NT	3.18		A		p ≤ .001
NF	3.26		A		
SF	3.74		A		
ST	4.02		A		

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

n = 127 a = .05

Table 18, Ranking of Mode of Presentation According to Mean Efficiency by Psychological Type, displays the seven modes of presentation (in descending order of efficiency) for each of the psychological types.

Investigative Question 9

The final investigative questions sought to determine if efficiency of problem solving was related to accuracy

Table 18.

Ranking of Mode of Presentation According to Mean Efficiency by Psychological Type

Extravert vs. Introvert

Extravert	Introverts
1. Bar w/ Tab Data	1. Bar w/ Tab Data
2. Line w/ Tab Data	2. Line w/ Tab Data
3. Tabular Data	3. Tabular Data
4. Pie w/ Tab Data	4. Pie w/ Tab Data
5. Bar Chart	5. Bar Chart
6. Line Chart	6. Line Chart
7. Pie Chart	7. Pie Chart

Sensing vs. Intuition

Sensing	Intuition
1. Bar w/ Tab Data	1. Bar w/ Tab Data
2. Line w/ Tab Data	2. Line w/ Tab Data
3. Tabular Data	3. Pie w/ Tab Data
4. Pie w/ Tab Data	4. Tabular Data
5. Bar Chart	5. Bar Chart
6. Line Chart	6. Line Chart
7. Pie Chart	7. Pie Chart

Thinking vs. Feeling

Thinking	Feeling
1. Line w/ Tab Data	1. Bar w/ Tab Data
2. Bar w/ Tab Data	2. Line w/ Tab Data
3. Tabular Data	3. Bar Chart
4. Pie w/ Tab Data	4. Tabular Data
5. Bar Chart	5. Pie w/ Tab Data
6. Line Chart	6. Line Chart
7. Pie Chart	7. Pie Chart

Table 18 continued on next page

Table 18 continued

Judgment vs. Perception

Judgment	Perception
1. Bar w/ Tab Data	1. Bar w/ Tab Data
2. Line w/ Tab Data	2. Line w/ Tab Data
3. Tabular Data	3. Tabular Data
4. Pie w/ Tab Data	4. Pie w/ Tab Data
5. Bar Chart	5. Bar Chart
6. Line Chart	6. Line Chart
7. Pie Chart	7. Pie Chart

Cognitive Styles Scale

STs vs. SFs

STs	SFs
1. Bar Chart	1. Bar Chart
2. Line Chart	2. Bar w/ Tabular
3. Pie Chart	3. Line w/ Tabular
4. Bar w/ Tabular	4. Line Chart
5. Line w/ Tabular	5. Pie w/ Tabular
6. Pie w/ Tabular	6. Pie Chart
7. Tabular Data	7. Tabular Data

NTs vs. NFs

NTs	NFs
1. Bar Chart	1. Line Chart
2. Line Chart	2. Pie w/ Tabular
3. Tabular Data	3. Pie Chart
4. Pie w/ Tabular	4. Line w/ Tabular
5. Line w/ Tabular	5. Bar w/ Tabular
6. Bar w/ Tabular	6. Tabular Data
7. Pie Chart	7. Bar Chart

of problem solving when using varying modes of presentation. The null hypothesis was: Efficiency of problem solving was not related to accuracy. Before this question could be answered, either variance of efficiency or variance of accuracy had to be demonstrated. Investigative question 2 demonstrated variance of accuracy and investigative question 7 demonstrated variance of efficiency.

For this question, efficiency was modeled as the independent variable and accuracy was modeled as the dependent variable. The one-way ANOVA provided an F-value of 2.57 with a $p \leq .0001$ (using 22 degrees of freedom). In his previous research, Thomas found the same level of significance (62:49). The coefficient of determination, R^2, accounted for 6.20% (.0620) of the variation. The pair-wise comparison using Duncan's Multiple Range test showed that no statistically significant differences existed between individual pairs. Table 19, Comparison of Mean Accuracy and Mean Efficiency of Problem Solving, provides the relationship between efficiency (time) and accuracy.

Though Duncan's Test showed no statistically significant pair-wise comparisons, some non-statistical trends were noted in Table 19. Of interest was the large number of subjects who completed problems in one (1) minute or less ($n = 263$). This most efficient group was also the

Table 19.

Comparison of Mean Accuracy and Mean Efficiency Of Problem Solving

Time in minutes (Efficiency)	Number of problems completed in this time frame	Mean Accuracy
1	263	127.3
2	181	56.8
3	123	42.2
4	82	44.8
5	80	41.9
6	26	39.9
7	29	34.0
8	17	52.1
9	14	29.4
10	18	59.6
11	7	9.0
12	8	13.4
13	5	23.4
14	3	9.7
15	10	15.4
16	1	24.0
17	3	13.0
18	2	5.0
19	1	0.0
20	3	2.7
24	1	1.0
30	1	43.0
31	1	19.0
	n = 879	$p \leq .0001$

group with the largest mean negative accuracy (error) -- $127.30 (compared to an average error of $68.84 for the total sample). At the other end of the spectrum, those subjects who used the most amount of time to solve a problem (11 or more minutes per problem) were more accurate in solving the problems (average error for these problems was $13.34 compared to an average error of $68.84 for the total sample). Again, no significance was

attached to either of these observations, but this non-statistical analysis appeared to show that the more efficient subjects were not necessarily the most accurate in decision making.

To summarize this investigative question, accuracy was correlated with efficiency. However, no statistically significant pair-wise differences were noted via Duncan's Multiple Range Test. These results reinforced Thomas' findings and matched his level of significance. Non-statistical analysis showed that efficiency was, in general, inversely related with accuracy.

Research Question

The research question was: Are psychological types related to the accuracy, preference, or efficiency of problem solving when using different modes of presentation of information? The null hypothesis for this question was: No relationship existed between the psychological type of an individual and the individual's accuracy, preference, or efficiency when using different modes of information presentation when problem solving.

This research question was based on investigative questions three, five, and eight. Question three showed that type was strongly correlated with accuracy. Question eight showed that psychological type was correlated with efficiency. Question five, overall, showed no statistical

correlation between type and preference for a mode of presentation. Accordingly, the answer to the research question was: Yes, psychological type was related to accuracy and efficiency of problem solving, but was not related to preference for a specific mode of information presentation.

Summary

This chapter offered an analysis of data necessary to answer the nine investigative questions. Statistically significant relationships were found to exist a) between the two sample groups, b) between the research sample and Campbell's sample of DOD employees, c) between accuracy and mode of presentation, d) between accuracy and type, e) between preference and mode of presentation, f) between efficiency and mode of presentation, g) between efficiency and type, and h) between efficiency and accuracy. No statistically significant relationships existed between a) between preference and type, and b) between preference and efficiency. Based on these investigative questions, the research hypothesis that no difference existed between a) psychological type and accuracy, and b) psychological type and efficiency was rejected. The research hypothesis that no relationship existed between psychological type and preference was accepted. The next chapter provides the recommendations and conclusions drawn from this research.

V. Conclusions and Recommendations

This chapter proffers both the conclusions and recommendations derived from this research. The conclusions of the nine investigative questions are presented along with any specific recommendations. Next, the conclusions of the research question are presented. Finally, recommendations concerning the gestalt of this research are presented as they impact Management Information Systems.

Investigative Question 1

Investigative Question 1 asked if the distribution of psychological types from the two samples were different from each other and different from the general public. First, the two samples were found to be similar to each other, thus allowing their data to be combined for further analyses. Secondly, this aggregate research sample was typologically similar to Campbell's sample of DOD employees, but typologically different from the SRI VALs estimate of the general population. Therefore, the results of this research can be generalized to mid- and executive- level managers in logistics related occupations, but not to the SRI VALs estimate.

A note of caution, however: the results of the Chi-Square analysis for this question may be suspect due to

the small sample size from the HQ AFLC population. This small sample size contained only one observation in the SF cell and only four observations in the NT cell. Just as Thomas noted, the "small sample size...increases the potential for error when generalizations are made" (62:51).

The first recommendation for this research is that a follow-on study be conducted, but with a larger sampling size. Had HQ AFMPC permitted this research to survey all 543 subjects as originally requested, at a minimum, all four cognitive styles would likely have been represented, allowing complete confidence in the Chi-Square results. Furthermore, approval for the requested sampling size could possibly have resulted in analysis not just of the five psychological scales, but of the full psychological types distribution (all 16 types). HQ AFMPC's decision to permit this research to sample only 134 subjects was not reflective of the larger sample size necessary to analyze all 16 psychological types.

Investigative Question 2

Analysis showed that the subjects' accuracy varied according to the seven modes of presentation. Analysis also showed that pie charts with tabular data resulted in the greatest accuracy while both forms of line charts were the least accurate. These findings collaborated Thomas' findings. Just as he (as well as Mason and Mitroff,

Thierauf, Benbasat and Dexter, and Dickson et al.) concluded, these findings have definite implications for designers of Management Information Systems (62:52; 39:478; 63:21; 4:67; 16:921). If managers are solving financial-oriented problems in their day-to-day jobs, then they should have at their disposal either form of pie charts, as the use of pie charts resulted in greatest accuracy of decision making. The opposite is true for line charts. Line charts resulted in the least accurate decision making. In this type of decision making situations, MIS designers should want to ensure that managers/MIS users have other presentation modes besides line charts and line charts with tabular data.

With current MIS technologies, the information presentation modes that result in greatest accuracy can, and should be, made readily available to managers/MIS users. Based on these findings, managers may not provide optimal solutions without the assistance of pie charts and pie chart with tabular data.

Investigative Question 3

The hypothesis that the psychological type of a subject had no relationship with the accuracy of problem solving was rejected. Though Myers and McCaulley claimed that no type was 'inherently superior to any other', this research showed that certain psychological types were

indeed superior to the others as far as accuracy of decision. Specifically, Introverts were more accurate than Extraverts, ($p \leq .03$), Sensing types were more accurate than Intuitives ($p \leq .0001$), Thinking types were more accurate than Feeling types ($p \leq .0001$), and Perception types were more accurate than Judgment types ($p \leq .02$). Finally, SFs were more accurate than STs, NTs, and NFs ($p \leq .001$).

The finding that Introverts were more accurate than the Extraverts supports Provost and Anchor's speculation that Introverts perform better in solving "detail oriented" problems (54:157). Lawrence's assertion that Extraverts favor "less complicated procedures" could explain their less accurate performance (32:2).

Why were the Sensing types more accurate than the Intuitive types? As noted in Chapter II, Lawrence also expected the Sensing types to be good at precise work and this type of problem required attention to detail and precision. Lawrence also noted that Intuitives prefer to pay attention to the meaning behind the facts. It is, therefore, possible that Intuitives are less accurate because they are more process oriented than problem oriented (32:3-4). Rather than committing their full energies to the problems they are asked to solve, the Intuitives, instead, mentally searched to comprehend the basis or merit of the survey problems.

Lawrence would also attribute the better performance of the Thinking types to their ability to use their preferred function (Thinking) to analyze and solve the 'logical and objective data' such as the financial problems used in this study. Conversely, the Feeling types were, perhaps, not able to use their favored function (Feeling) but instead had to rely on their Thinking function. The IPMS offered the Feeling types no opportunity to incorporate their subjective values in the decision making function. (32:3-4)

Kroeger and Thuesen explain that the Perceptive types' better performance is due to their willingness to 'welcome new information' when making decisions. As opposed to the Judging types who prefer 'decisiveness', the Perceptive types delay their decision making until they feel they have all the information necessary to make a decision. (31:42; 49:69)

Finally, the significant differences that existed between the four cognitive styles support Henderson and Nutt's assertion that these four combinations have a 'unique approach to decision making' (20:373). The results of this study contradict Huber's claim that cognitive style has no impact on the design of a MIS (23:567). On the contrary, the data appears to add more credence to Watkins's claim that 'information reports can

be tailored to homogeneous groups of the same psychological type' (65:7).

With the findings of this research, what recommendations can be suggested for MIS designers and users? Based on this research, solutions to problems are more accurate by some MIS managers/users (I's, S's, T's, and P's) than others (E's, N's, F's, and J's). Thus, if accuracy is important in the decision making process, then different psychological types can best satisfy this need. Again, if accuracy is important, then some psychological types should play a less influential role in the decision making process. It is possible that a specific audience can be targeted to serve as decision makers for the variety of problems this research modeled.

Investigative Question 4

The null hypothesis that subjects had equal preference for all modes of information presentation was solidly rejected (p-value = 0.0). These research subjects preferred bar charts with tabular data the most and pie charts the least. The subjects not only differed in their preference for the modes of presentation, but they also preferred any mode that contained tabular data over modes without tabular data.

But what are the MIS design implications of this finding? If user satisfaction, as measured by preference, is the over-riding factor, then the answer is to give the

decision maker the kind of information he/she wants. And the kind of information presentation the decision maker wants in this type of problem is, generally, any presentation mode as long as it includes tabular data. In contrast, decision makers do not want any modes of presentation without tabular data. These finding generally reinforce the findings of Zmud, Jarvenpaa et al., and Benbasat and Dexter (66:195; 4:67; 26:149).

However, MIS designers must grapple with the problem that the mode that the user prefers is not always the mode with which the user is most accurate. This research shows that bar charts with tabular data were the most preferred mode, but resulted in just the fourth most accurate decisions. Similarly, line charts with tabular data were the second most preferred mode, while being the least accurate mode of presentation. Conversely, pie charts were the least preferred but resulted in the second most accurate decisions. From this research, it appears that preference can be optimized, but at the expense of accuracy of decision making.

Investigative Question 5

This question determined that the psychological type of a subject was not related to preference for any of the seven modes of presentation. With two exceptions, none of the 35 analyses showed a statistically significant

relationship between type and preference ranking. The two exceptions were the J/P scale for bar charts ($p \leq .04$) and bar charts with tabular data ($p \leq .01$). In these cases, the Judgment types preferred bar charts and bar charts with tabular data more than the Perception types preferred the same modes.

Overall, psychological types did not exhibit a statistically significant difference in preference for modes of information presentation in this research. Based on this data, Management Information Systems designers have no need to consider this criteria when they develop systems for end-users. It appears from this research that preferences for different modes of information may have been due to the mode of presentation, itself, rather than being due to psychological type.

One recommendation that can be made from this finding is a follow-on recommendation to investigative question 4. Since user psychological types do not affect modal preference, then MIS designers can satisfy managers/ MIS users by providing those modes that were shown to be preferred in question 4: those modes that, at least, include tabular data.

Investigative Question 6

Investigative question 6 determined that preference for a mode of presentation was not related to accuracy of decision making. Duncan's Test also failed to show any

statistically significant relationship between accuracy and preference rankings. Though accuracy varied and preference also varied, these two factors were not correlated. These phenomena should be further examined to determine what causes the variations.

These findings do have implications for MIS designers. Since these two factors are independent, then MIS designers should offer both factors in the information system and allow management to prioritize and implement the one deemed the most important to them.

From these results, it appears that the MIS user must decide which is most important: accuracy or user preference. This research shows that accuracy can be optimized with pie charts or pie charts with tabular data. But, if user satisfaction is the over-riding consideration, then tabular data should be included with all modes of presentation.

Investigative Question 7

The null hypothesis was that subjects had equal efficiency when solving problems using different modes of presentation. This hypothesis was rejected with a level of significance $\leq .0001$. The analysis showed that bar charts and line charts were the most efficient modes of presentation. The three modes of presentation alone (without the aid of tabular data) were the three most

efficient modes of presentation; the four modes using tabular data were the four least efficient modes of presentation.

These findings indicated that if efficiency is important, then tabular data should be avoided entirely. These results reinforced Thomas' findings (62:54). Similarly, they reinforce Benbasat and Dexter findings that subjects using graphical modes took significantly less time to make decisions than those using tabular data (4:78).

The results differed with the findings of Ghani and Lusk (19:276), who found no relationship between efficiency and mode of presentation. These findings also contradict the conclusions drawn by Benbasat and Dexter that graphs "may be disadvantageous" since it is difficult and time consuming to get an exact value (4:67). These results have shown that it is more time consuming to read and interpret tabular data. It appears that no definitive answer has been provided as to which mode of presentation is most and least efficient. Therefore, this question is still open for further study.

Knowing the results of this study, what recommendations can be made for designers of Management Information Systems? From these findings, certainly, adding tabular data to any mode of presentation will decrease efficiency of problem solving. As Thomas noted, if "data lends

itself to graphical representation then it should be graphed' (62:54). But if data cannot be readily graphed, MIS designers should expect sub-optimal efficiency.

Information system users must also determine if efficiency is important to the decision making process, and if yes, then determine to what extent it is important. It may (or may not) be important enough to shy away from using any form of tabular data. With the increased emphasis on information systems and office automation, managers can readily have the information presented in the manner they request; managers must decide how important efficiency of problem solving is: if it is of utmost importance, then tabular data should be avoided.

Investigative Question 8

The null hypothesis that psychological type was not related to efficiency of problem solving when using different modes of presentation was rejected. Three of the five psychological scales showed statistically different efficiencies: S/N ($p \leq .001$), ST/SF/NT/NF ($p \leq .001$) and J/P ($p \leq .01$).

Specifically, Intuitives were more efficient than Sensors by almost 3/4 of a minute per problem, and Judgment types were more efficient than Perception types by almost 3/4 of a minute per problem. Similarly, NTs were the most efficient of the four cognitive styles and STs were the least efficient at problem solving. In fact,

both Intuitive types (NTs and NFs) were more efficient than the Sensing types (STs and SFs). Time was not statistically different for Extraverts and Introverts, nor for Thinking types and Feeling types.

As mentioned in Chapter II, Myers would attribute the Intuitives' faster performance to their 'masculine hunch', and 'woman's intuition', resulting from 'a jump from the known and established...[to] an advanced point, with the intervening steps apparently left out' (48:57). She would also attribute the Sensing types' slower performance to them being 'more accurate in simple computations because they are more careful than the Intuitives' (48:61). This explanation could apply equally to the finding that both Intuitive cognitive styles (NTs and NFs) were more efficient than either of the Sensing (STs and SFs) cognitive styles.

Kroeger and Thuesen, and Myers and McCaulley, would explain that the Judgment types' faster performance was due to their 'decisiveness', while Perception types delay their decision making until they feel they have all the information necessary to make a decision. (31:42; 49:69)

What implications does this have for MIS designers? Assuming efficiency is desired, specific users can be targeted for solving financial-oriented problems. In particular, Intuitives will provide faster solutions than Sensing types. Cumulatively, this better efficiency can

be considerable in a situation where time is of the essence and the problems are repetitive in nature.

Investigative Question 9

The null hypothesis that efficiency of problem solving was not related to accuracy was rejected ($p \leq .0001$). Thomas found the same probability (62:49). Even with this significance level, the multiple comparison test determined that no significant differences existed between individual pairs. Even so, trend analysis showed that, in general, greater efficiency of problem solving was not related with greater accuracy. On the other end of the spectrum, those subject who used greater amounts of time were more accurate in solving problems.

MIS designers should note that if accuracy is to be optimized, the decision makers may need more time to make better decisions. Based on this research, if users are pressured into answering quickly, decisions may not be as accurate as when users are unconstrained by time. From this apparent (though non-statistically supported) inverse relationship between time and accuracy, a MIS user/manager should be given as much time as necessary to solve problems. Failure to do so might result in sub-optimal decision making.

Research Question

The research question that psychological types are not related to the accuracy, preference, or efficiency of problem solving when using different modes of presentation of information was rejected. Specifically, psychological type was found to be strongly correlated with accuracy and efficiency; psychological type was not found to be correlated with preference for a mode of presentation.

Thus, what recommendations can be made for MIS designers based on these findings? Accuracy of decision making and efficiency of decision making are inversely related: better accuracy is correlated with more time (less efficiency), and vice versa. Therefore, managers will have to determine which of these two variables is most important in problem solving. If accuracy is the primary design criterion, then provide the user with the mode of information that results in greatest accuracy: pie charts with tabular data. If efficiency of problem solving is the primary design criterion, then provide the user with bar charts.

Two other recommendations are suggested. First, the MIS should offer the user different modes of presentation and let the user decide which factor they want: greater efficiency or greater accuracy in the decision making process. Also, users might be trained to

use other modes of presentation in order to gain optimum accuracy or efficiency.

Research Recommendations

The first research recommendation is to repeat this study with a different population. Both Thomas' research and this research examined DOD managers, primarily military managers in an academic environment. Future researchers are advised to conduct a similar study in the civilian sector.

A second recommendation is that HQ AFMPC approve a follow-on study with a larger sample size. A larger sampling size might enable the full type distribution to be analyzed, providing complete identification of psychological type instead of relying on the five scales. With the small sampling size approved for this research, most of the sixteen psychological types were under-represented, resulting in the condensation of the sixteen types into the five scales. It's possible that all sixteen types could have been analyzed had the original sampling plan been approved as requested.

Another recommendation is to simplify the IPMS. A number of subjects commented on the perceived difficulty of the problems. Those graphs that were accompanied by tabular data were often perceived as 'busy' problems: a lot of information on one page. A possible solution to this perception of busy graphs would be to reduce the

number of stores from twenty to ten or twelve. Obviously, this would reduce the amount of information on each graph. Also, it might encourage additional participation by those subjects who declined to participate because of the perceived difficulty of the problems. Finally, this recommendation might reduce the amount of time necessary to complete the problems, a not too infrequent complaint.

A final recommendation is that this study be replicated but with a reduced scope. Other researchers have examined mode of presentation and accuracy, efficiency, and preference. No other research has examined the full psychological type distribution for the dependent variables of accuracy, efficiency, and preference. Further research is recommended as it examines psychological type and accuracy, preference, and efficiency of decision making. But continuing to examine the relationships between mode of presentation and accuracy, efficiency, and preference only reinforces, rather than adds new information to, past research on these relationships. Examining the relationship between all sixteen psychological types and accuracy, preference, and efficiency has yet to be fully addressed.

Appendix A: The Information Presentation Mode Survey

PART =2

INFORMATION PRESENTATION MODE SURVEY

by Eric Thomas

This part of the survey is the Information Presentation Mode Survey (IPMS). The IPMS is a quantitative measure of how well individuals make decisions when using different modes of presentation: tables of data, pie charts, bar charts, line graphs, or combinations of these modes. Specifically, the IPMS measures accuracy and efficiency in solving problems. Finally, it allows individuals to rank order their preference for each mode of presentation.

INSTRUCTIONS

For each of the following seven problems (A through G), assume you are the regional director of a national pizza chain -- PIZZA PIZZAZZ -- and you have a decision to make. The national headquarters of PIZZA PIZZAZZ has determined that you can open twenty (20) new stores in your region. You have conducted an extensive market survey, which is highly reliable, and you have narrowed your choices down to three (3) candidate cities in each problem. Everything else between the three cities being about equal, you are going to use profit amounts to decide the number of stores to place in each city. The market survey gave you weekly profit figures for the existing stores in each city.

ASSUMPTIONS

1. **You are to maximize your profits for each problem.**

2. **Based on the information presented in each problem**, you are to spread the twenty (20) new PIZZA PIZZAZZ stores among the three (3) cities.

3. You can allocate from zero (0) to twenty (20) stores to any one city for each problem.

4. **You must allocate all twenty (20) stores** for each problem

CONSTRAINTS

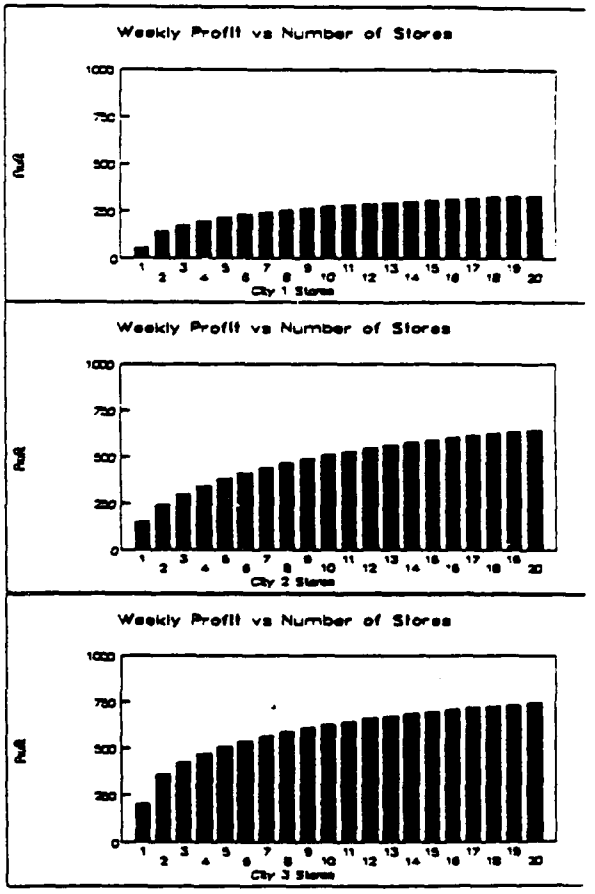
1. **Each of the seven problems (A-G) has a different set of profit values**. Therefore, the number of new stores you give to each city may differ for each of the seven problems.

2. Some of the problems have the information presented in bar charts, pie charts, line charts, tabular data, or combinations of a chart and tabular data. Again, use only the information given for that specific problem.

USAF SCN 89-58

EXAMPLE

No. of Stores	City 1 Stores	City 2 Stores	City 3 Stores
1	98	158	200
2	148	240	356
3	172	296	420
4	195	341	467
5	213	379	504
6	228	411	534
7	241	439	560
8	252	465	583
9	262	487	604
10	272	508	622
11	280	527	639
12	288	544	654
13	295	560	668
14	302	575	681
15	308	588	693
16	314	601	704
17	320	613	714
18	325	624	724
19	330	634	733
20	335	644	742



THREE POSSIBLE SOLUTIONS FOR THIS EXAMPLE

#1			#2			#3		
Number of Stores		Profit	Number of Stores		Profits	Number of Stores		Profit
City 1:	7	$241	City 1:	4	$195	City 1:	0	$0
City 2:	5	$379	City 2:	4	$341	City 2:	10	$508
City 3:	8	$583	City 3:	12	$654	City 3:	10	$622
Totals	20	$1203	Totals	20	$1190	Totals	20	$1130

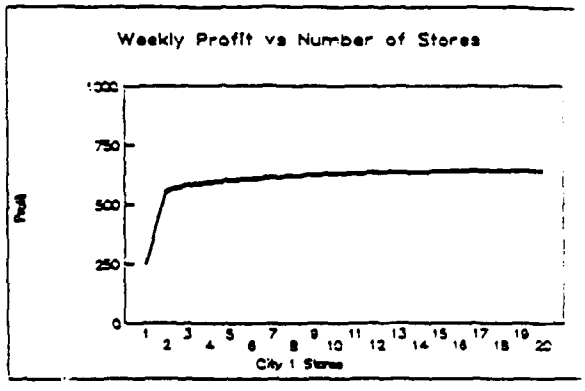
*** REMEMBER ***

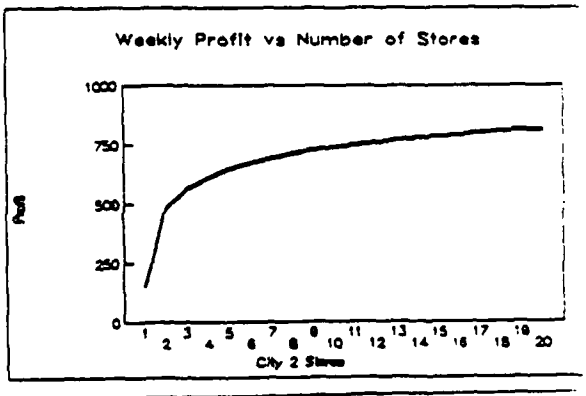
- ATTEMPT TO MAXIMIZE PROFIT IN EACH PROBLEM
- USE ALL 20 STORES IN EACH PROBLEM
- DATA AND VALUES ARE DIFFERENT FOR EACH PROBLEM
- WRITE DOWN THE START TIME AND THE STOP TIME FOR EACH PROBLEM

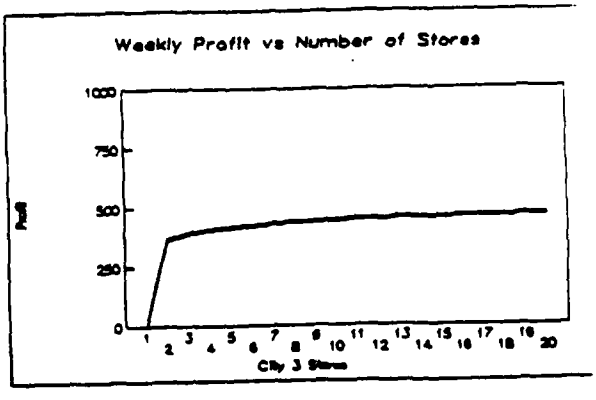
PROBLEM A

START TIME_____

No. of Stores	City 1 Profit	City 2 Profit	City 3 Profit
1	150	150	10
2	240	482	365
3	296	562	391
4	341	611	406
5	379	646	417
6	411	673	425
7	439	695	431
8	465	712	436
9	487	728	440
10	508	741	444
11	527	753	447
12	544	763	450
13	560	772	452
14	575	780	455
15	588	788	456
16	601	794	458
17	613	801	460
18	624	806	461
19	634	812	462
20	644	816	463







No. of Stores for City 1 _____

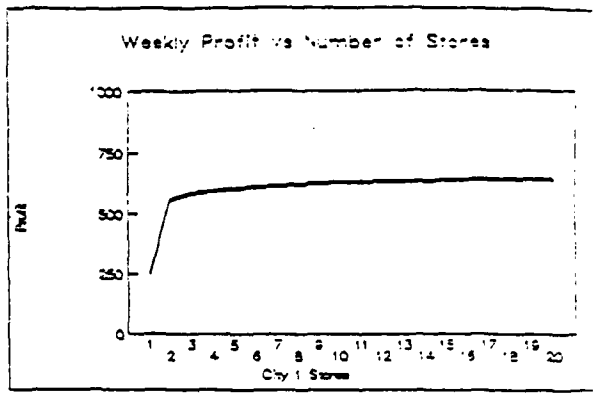
No. of Stores for City 2 _____

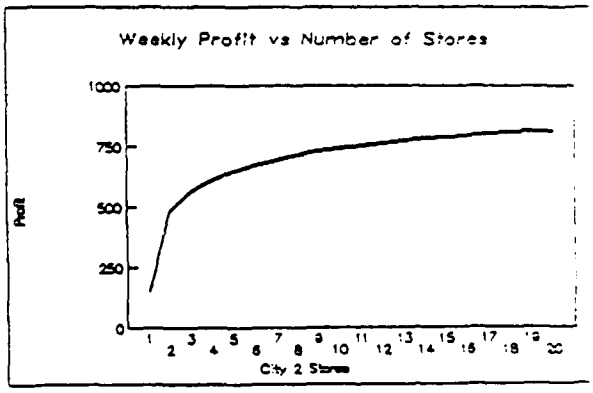
No. of Stores for City 3 _____

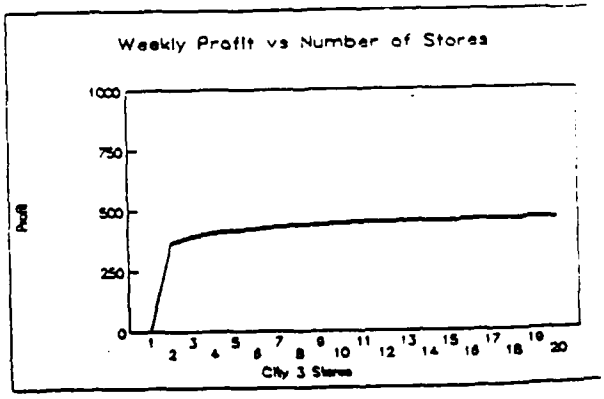
STOP TIME: _____

PROBLEM 3

START TIME_____







No. of Stores for City 1 _____

No. of Stores for City 2 _____

No. of Stores for City 3 _____

STOP TIME: _____

PROBLEM C

START TIME_____

Legend for Pie Slice Descriptors:
****

A: Stores 1 and 2
B: Stores 3 and 4
C: Stores 5 and 6
D: Stores 7 and 8
E: Stores 9 and 10
F: Stores 11 and 12
G: Stores 13 and 14
H: Stores 15 and 16
I: Stores 17 and 18
J: Stores 19 and 20

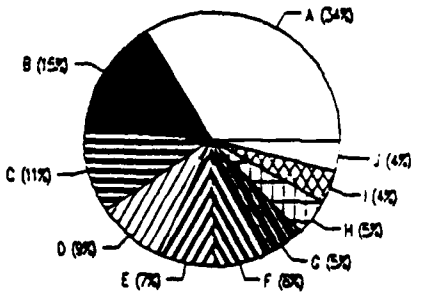
No. of Stores for City 1 _____

No. of Stores for City 2 _____

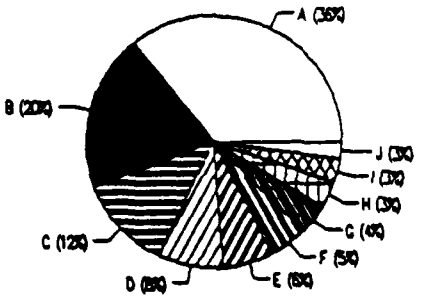
No. of Stores for City 3 _____

STOP TIME: _____

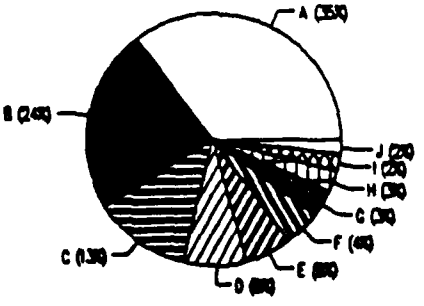
Profit at 20 Stores = $463
City 1



Profit at 20 Stores = $691
City 2



Profit at 20 Stores = $791
City 3



PROBLEM 2

START TIME_____

Legend for Pie Slice Descriptors:
****

A: Stores 1 and 2
B: Stores 3 and 4
C: Stores 5 and 6
D: Stores 7 and 8
E: Stores 9 and 10
F: Stores 11 and 12
G: Stores 13 and 14
H: Stores 15 and 16
I: Stores 17 and 18
J: Stores 19 and 20

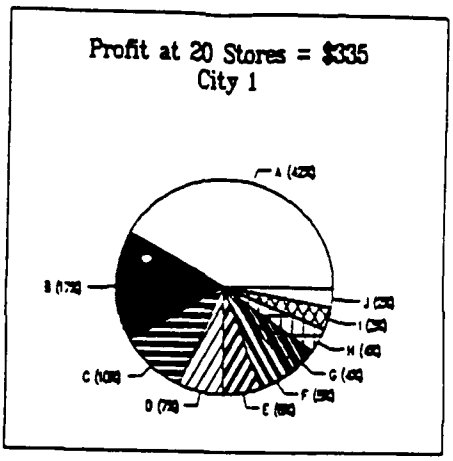
No. of Stores	City 1 Profit	City 2 Profit	City 3 Profit
1	50	300	50
2	140	378	280
3	172	417	391
4	195	447	466
5	213	472	522
6	228	494	566
7	241	514	601
8	252	531	630
9	262	547	655
10	272	562	676
11	280	576	694
12	288	589	710
13	295	600	725
14	302	612	737
15	308	622	748
16	314	632	759
17	320	642	768
18	325	651	776
19	330	659	784
20	335	667	791

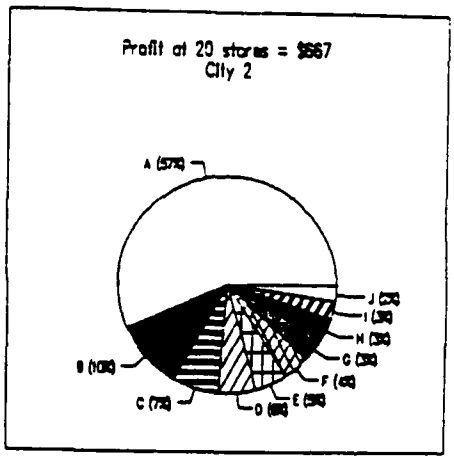
No. of Stores for City 1 _____

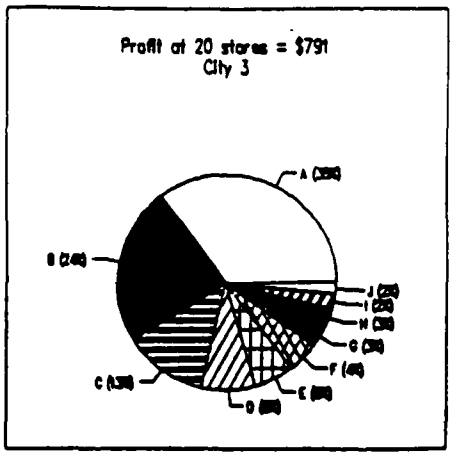
No. of Stores for City 2 _____

No. of Stores for City 3 _____

STOP TIME: _____

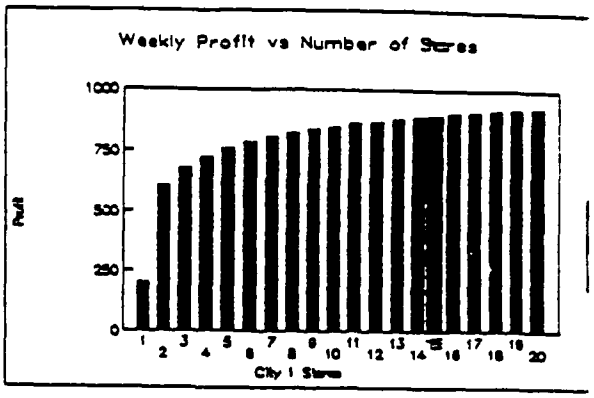


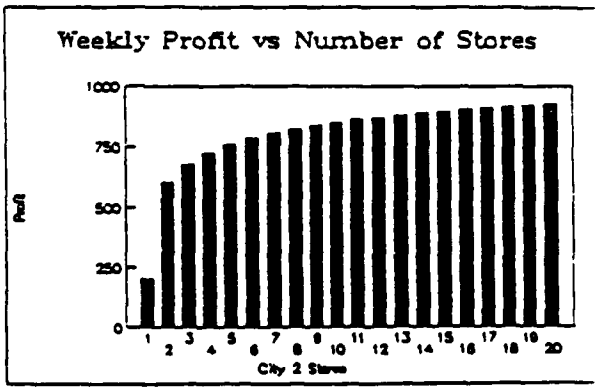


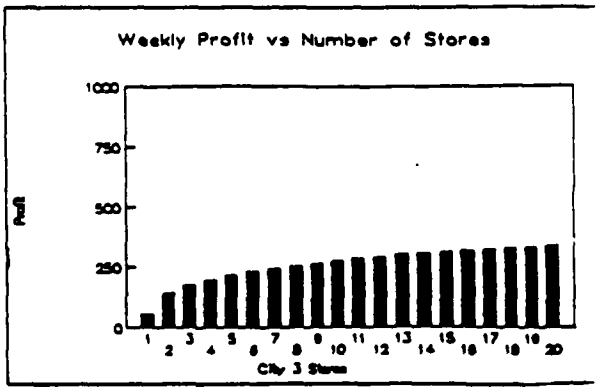


PROBLEM 3

START TIME_____







No. of Stores for City 1 _____

No. of Stores for City 2 _____

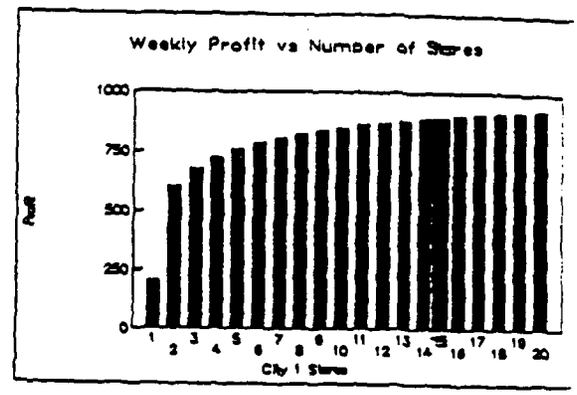
No. of Stores for City 3 _____

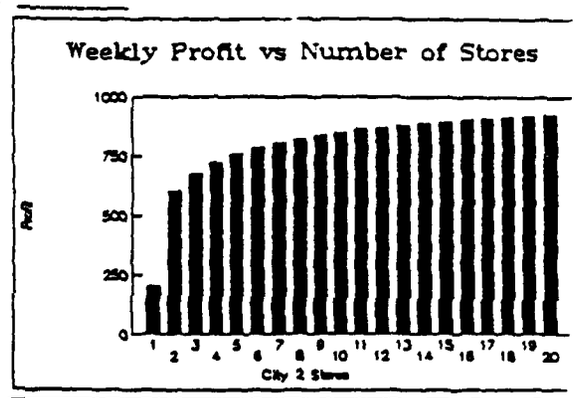
STOP TIME: _____

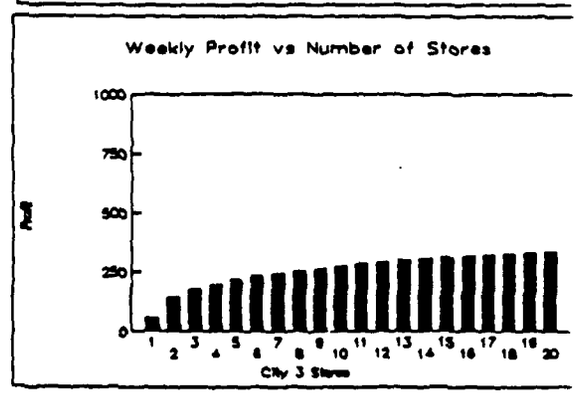
PROBLEM_F_____

START TIME_____

No. of Stores	City 1 Profit	City 2 Profit	City 3 Profit
1	200	150	50
2	599	240	140
3	675	296	172
4	721	341	194
5	754	379	213
6	780	411	229
7	801	439	241
8	819	465	252
9	834	487	262
10	847	508	272
11	858	527	280
12	868	544	288
13	878	560	295
14	886	575	302
15	894	588	308
16	901	601	314
17	907	613	320
18	913	624	325
19	918	634	330
20	924	644	335







No. of Stores for City 1 _____

No. of Stores for City 2 _____

No. of Stores for City 3 _____

STOP TIME: _____

PROBLEM G

START TIME_____

Number of Stores	City 1 Profit	City 2 Profit	City 3 Profit
1	$ 50	$250	$100
2	140	313	573
3	172	346	606
4	195	371	626
5	213	392	639
6	228	410	649
7	241	426	657
8	252	440	663
9	262	452	669
10	272	463	674
11	280	474	678
12	288	483	681
13	295	492	685
14	302	500	688
15	308	508	690
16	314	515	692
17	320	521	694
18	325	528	696
19	330	533	698
20	335	539	700

No. of Stores for City 1	No. of Stores for City 2	No. of Stores for City 3
_____	_____	_____

STOP TIME_____

Now that you have completed all seven problems, please rank order your preference for the methods information was presented to you in this survey. Use the numbers from 1 to 7 to indicate how you preferred the information presented, with 1 being your most preferred -- on down to 7, your least preferred method.

RANK	METHOD
___	Line graph alone
___	Line graph with columns of figures
___	Bar chart alone
___	Bar chart with columns of figures
___	Pie chart alone
___	Pie chart with columns of figures
___	Columns of figures alone

Please mark one of the two statements below if unable to rank order your preferences:

___ I prefer all methods of presentation equally well
___ I don't prefer any of the methods of presentation

REMINDER: If you have not already done so, please write your name on this page. This data will remain confidential and will not be attributed to you personally.

Appendix B: Comparison of Psychological Types and Preference By Mode of Presentation

Line Chart with Tabular Data

Type	Mean Preference	Duncan's Grouping	P-value
E	2.76	A	p ≤ .25
I	2.49	A	
S	2.52	A	
N	2.59	A	p ≤ .77
T	2.48	A	
F	2.86	A	p ≤ .24
J	2.53	A	
P	2.59	A	p ≤ .78
ST	2.30	A	p ≤ .16
NT	2.05	A	
NF	1.91	A	
SF	1.50	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

n = 127 (alpha) = .05

Tabular Data

Type	Mean Preference	Duncan's Grouping	P-value
E	3.59	A	
I	3.83	A	p ≤ .58
S	3.54	A	p ≤ 16
N	4.08	A	
T	3.68	A	
F	4.14	A	p ≤ .35
J	3.83	A	p ≤ .60
P	3.62	A	
NF	4.27	A	p ≤ .51
NT	4.03	A	
SF	3.89	A	
ST	3.49	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

---

n = 127 (alpha) = .05

Bar Chart with Tabular Data

Type	Mean Preference	Duncan's Grouping	Significance Level
E	1.97	A	p ≤ .33
I	2.19	A	
S	2.19	A	p ≤ .42
N	2.02	A	
T	5.07	A	p ≤ .49
F	4.81	A	
J	1.94	A	
P	2.48	B	p ≤ .01
NF	3.18	A	p ≤ .41
ST	2.52	A	
SF	2.50	A	
NT	2.41	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

n = 127 (alpha) = .05

Pie Chart

Type	Mean Preference	Duncan's Grouping	P-value
E	5.92	A	p ≤ .86
I	5.86	A	
S	5.97	A	p ≤ .40
N	5.71	A	
T	5.83	A	p ≤ .53
F	6.09	A	
J	6.10	A	
P	5.45	A	p ≤ .052
SF	6.30	A	p ≤ .74
ST	5.94	A	
NF	5.91	A	
NT	5.66	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

---

n = 127 (alpha) = .05

Bar Chart

Type	Mean Preference	Duncan's Grouping	P-value
E	4.62	A	p ≤ .97
I	4.63	A	
S	4.74	A	p ≤ .30
N	4.47	A	
T	4.73	A	p ≤ .08
F	4.14	A	
J	4.44	A	
P	4.98	B	p ≤ .04
ST	4.77	A	p ≤ .21
NT	4.66	A	
SF	4.50	A	
NF	3.82	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

---

n = 127 (alpha) = .05

Pie Chart with Tabular Data

Type	Mean Preference	Duncan's Grouping	P-value
E	3.89	A	
I	3.89	A	p ≤ .99
S	3.86	A	p ≤ .81
N	3.94	A	
T	3.80	A	p ≤ .19
F	4.33	A	
J	3.89	A	
P	3.90	A	p ≤ .96
SF	4.50	A	p ≤ .59
NF	4.18	A	
NT	3.87	A	
ST	3.76	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

---

n = 127 (alpha) = .05

Line Chart

Type	Mean Preference	Duncan's Grouping	P-value
E	5.21	A	p ≤ .37
I	4.94	A	
S	4.99	A	p ≤ .74
N	5.08	A	
T	5.07	A	p ≤ .49
F	4.81	A	
J	5.02	A	p ≤ .99
P	5.02	A	
NT	5.18	A	p ≤ .83
ST	5.00	A	
SF	4.90	A	
NF	4.73	A	

NOTE: For each Duncan's Groupings, the means with the same letter were not significantly different.

---

n = 127 (alpha) = .05

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[redacted]

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distributin unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GIR/LSM/89D-4	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION School of Systems and Logistics 6b. OFFICE SYMBOL (If applicable) AFIT/LSY	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Air Force Institute of Technology Wright-Patterson AFB OH 45433-6583	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
THE EFFECTS OF PSYCHOLOGICAL TYPE AND INFORMATION PRESENTATION ON DECISION MAKING

12. PERSONAL AUTHOR(S)
Jerry M. Kain, B.A., Capt, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
MS Thesis	FROM _____ TO _____	1989 December	148

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	MBTI (Myers-Briggs Type Indicator), Psychological Type, Cognitive Style, Information
05	01		

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

THESIS ADVISOR: Dennis E. Campbell
Associate Professor

Approved for public release: IAW AFR 190-1.
Larry W. Emmelhainz
LARRY W. EMMELHAINZ, Lt Col, USAF 12 Jan 90
Director of Research and Consulting
Air Force Institute of Technology (AU)
Wright-Patterson AFB OH 45433-6583

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Dennis E. Campbell, Assoc. Professor	22b. TELEPHONE (Include Area Code) 513-255-5023 / 22c. OFFICE SYMBOL AFIT/LSM

DD Form 1473, JUN 86 *Previous editions are obsolete.*

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Abstract

This research investigated the relationship between the user's psychological type and mode of information presentation. One hundred twenty-seven Department of Defense managers served as subjects.

The Myers-Briggs Type Indicator was utilized to identify the psychological type of the users while the Information Presentation Mode Survey determined accuracy, efficiency, and preference for seven modes of presenting information or decision making. Because some of the sixteen types were under-represented, psychological type was instead analyzed via five scales: ST/SF/NT/NF, E/I, S/N, T/F, and J/P.

Psychological types were found to vary in their accuracy of decision making. Specifically, Introverts were more accurate than Extraverts, Sensing types were more accurate than Intuitive types, Thinking types were more accurate than Feeling types, and Perceptive types were more accurate than Judgment types. SFs were more accurate than STs, and NTs; NFs were least accurate.

Statistically significant relationships existed between psychological type and efficiency of problem solving. Intuitives and Judgment types were more efficient than Sensing and Perception types by about 45 seconds per problem. NTs and NFs were almost a half a minute faster per problem than STs and SFs.

Statistical analyses determined that significant relationships also existed a) between accuracy and mode of presentation, b) between preference and mode of presentation, c) between efficiency and mode of presentation, d) and between efficiency and accuracy.

No statistically significant relationships existed between a) between preference and type, and b) between preference and efficiency.

These findings have implications for designers of Management Information Systems. Recommendations are offered as to how best present information to MIS users to optimize decision making.